THE MAKING OF A MECHANICAL OPTICIAN

A PRACTICAL TREATISE ON THE MECHANICAL WORK OF OPTOMETRISTS AND OPTICIANS

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WITH ILLUSTRATIONS

THE KEYSTONE PUBLISHING COMPANY
809-811-813 NORTH 19TH STREET
PHILADELPHIA, PA.

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CHAPTER I

Selecting, Installing and Operating the Machinery

In beginning this treatise we have in mind partially the optician who is considering the advisability of installing a plant to do his own work, and, naturally, the first question to decide is whether it is advisable to install such a plant. The arguments in favor of doing so are the following: The accommodation to your customer, the new customers it will bring by advertising that you do your own work and the extra profit. The arguments against it are: The extra responsibility and labor it will put upon you; have you enough prescription work to make it an object, and if so, can you afford to hire a man, and would it not be advisable to use the time that you would put into this work to develop your refracting business?

This matter you can best decide for yourself, but, assuming that you decide to take the step, the next thing is to lay the plans for your shop and select the machinery.

It was formerly the custom to engage an attic room in some old building on a side street, order a grindstone and engage carpenters and machinists to fit it up. As it was impossible to estimate the expense, it frequently was exorbitant. Now that has all changed, as it is possible to purchase an entire outfit, ready to run, at a nominal cost. This not only saves a great deal of worry, but you can figure the cost almost to a cent.

Another great advantage is that the outfit, sold by the wholesalers to-day, can be used in any office, even with a rug on the floor, and can be kept as clean as a piece of furniture.

The best place for a bench depends somewhat on the circumstances. Some prefer to have an extra room for this work; others fit up part of the refracting room or the reception room. If you have an office, consisting of only one room, you can perhaps select a corner near a window, and, if you prefer, you can stand a screen in front of it. If you have a store, it will be a good idea to place the bench in a prominent position, even in the window, if possible,

thus enabling you to take advantage of the advertising possibilities. This question of space and location, however, is not of very much importance, as there are benches on the market that require very little room. We have in mind particularly the Simplex Bench, which is but 4 ft. long by 16 in. wide.

Having well considered these facts, we now proceed to select the outfit. This is a matter which should be given considerable attention. It certainly is false economy to buy cheap machinery, as it not only gives trouble, but wears out sooner and has to be replaced in a few years. With the best, a great deal of work is done automatically, requiring less time and attention, and one does not need to be an expert to do good work. If you are not limited as to space, we would suggest a bench 4 ft. long by 32 in. wide. This will give you sufficient room to lay out your work, so that you can handle it easily.

After deciding on the bench, the next thing is to select the frameless machine. The four most prominent on the market are the Acme, Gem, Monarch and Simplex. The Acme is a large machine, with a stone 24 in. in diameter and 1½ in. face. It is designed to do heavy work and can be used for both prescription and stock grinding. By this we mean grinding up quantities of interchangeable sphericals and cylinders. The Gem is a medium-sized machine, designed more especially for prescription work, but stock can be ground on it also, but not in such large quantities. It has a composition stone, 18 in. diameter by 2 in. face, and it has been very popular with the shop men for several reasons. In the first place, it is very simple and can be taken apart and put together very easily. It also has a hand wheel for turning the lenses, which is very convenient when in a hurry, to grind off any bunches on the lens, if not properly cut. The Acme and Simplex have a hand wheel for the same purpose.

The "Monarch" is a machine of medium size, not as large as the Gem or as small as the Simplex. It has a 16-inch composition stone with either 1¼ or 1½-inch face and requires only a quarter or a sixth h. p. to operate. This machine will edge from one single lens to as many as will occupy the width of the stone, all lenses being constantly kept on the stone. The stone can be tipped back out of the trough when desired. The machine can be used on the bench or separately with stand or legs.

Whichever machine you decide on be sure to get a composi-

tion stone, as a Craigleith requires constant care and never works as satisfactorily. These composition stones are very hard, and will keep in shape sometimes for years. Either size is all right for hand work. We might state that it is really better to have a separate stone for hand work, as it enables you to keep your frameless machine in better condition. In grinding over a

Fig. 1—Reception room and modern workbench

machine the water runs off the hands on to the machine. This is full of grit, and unless you clean the machine every day it will soon become gummed up and in time refuse to work. If you install the Simplex, however, you should have an extra stone, which can be obtained for about fifteen dollars. The Simplex is the latest machine on the market, and is designed particularly for prescription work. The stone is but 10 in. diameter and 1 in. face.

The machine, however, is built just as heavy as the large ones, and particular attention has been given to the wearing qualities. The idea of using this small stone is to take up less space and to require less power (a 1/6 h. p. motor will operate it), and then the stone can be replaced at a small cost. Another advantage is in case of repairs it can be boxed easily and shipped to the factory at a small expense. This will be appreciated by anyone having had occasion to renew broken parts or turn up a stone on a large machine. Frequently it has been necessary to pay a man's expenses from the factory or jobbing house to do this work, or if the machine has to be sent to the factory it must be crated and shipped by freight.

The selection of one of these machines will depend on the circumstances and requirements of your work. It should, however, be placed at the right hand end of your bench, as you will find it more convenient. There are many good drills on the market, and samples of these can be seen at all the large jobbers, or a good idea of them can be obtained by consulting the different catalogues. You can obtain a low-priced diamond drill, without a centering device, that does excellent work, but requires more experience in centering the lenses. There is a separate centering device on the market that can be obtained for a small sum. Opticians having old-style drills will find this a great convenience in marking lenses for drilling, as it centers them instantly and accurately. It also has a scale for drilling above and below center.

If you can afford it, we should recommend a drill with the centering device and also an arrangement for drilling torics, such as the Universal (Standard Optical Company's) or the American Optical Company's drill. You should, by all means, use a diamond point, although these are not guaranteed. With a little instruction and by using care you will seldom break one. In selecting the diamond we would recommend a white splint, as this has a rough point and cuts faster. It also can be sharpened at less expense. If you break it, you can replace it for about five dollars. The turned diamond can be had in white stones or black carbon, and these cost from twelve to eighteen dollars. These are, perhaps, less liable to break, but do not cut as fast. (In reality, they grind a hole.) They cost more to sharpen, besides having to be done oftener.

Next is the cutter, and this should be placed on a square board, so that it can be moved back out of the way when not in use. There are only four on the market, which are used to any great extent, and these are: The American Optical Company; Little Gem (Bausch & Lomb Optical Company); Standard and Globe. The American Optical Company's is arranged so that most of the different shapes and sizes can be cut by adjusting the micrometer head according to a scale furnished with the machine. The Standard is operated by one large pattern with a groove in the under side. In place of a micrometer there is a five-sided barrel with the two rolls that run in the groove in the pattern arranged at

Fig 2—The old-time shop

different distances, so that by turning it you can cut the shapes, having a difference between the length and width of ten, nine, eight, seven and six millimeters. This machine is furnished with a steel wheel, but it can be obtained with a diamond, by paying extra.

The little Gem has an adjustable pattern, and by adjusting both the pattern and micrometer head, according to a chart furnished with it, you can cut most all the ovals. While this scale is nearly right, we would suggest that you make a scale of your own, for the regular shapes, for accurate work. This can be done by cutting old lenses and measuring them until you find just the right amount to allow for grinding. The Globe is arranged by a series of patterns, so that it will cut any size or shape. These are changed instantly by lifting the top gear. It has a micrometer,

arranged with a pointer, so that the frameless sizes are read in millimeters, and the frame sizes in the regular way, 1, 0, 00, etc. This scale is also arranged so that it is set for regular and full eye, without any difficulty, and without consulting a chart. To cut a lens 40 x 33, subtract the width from the length (this is seven millimeters). By placing No. 7 pattern in the machine and setting the pointer at 40 mm., you get the required size. These patterns also interchange with those on Acme and Simplex machines. This you will find very convenient.

Just here we will put in a word about diamonds. Quite frequently we hear that someone wants a cutting diamond sharpened. This is impossible, as a cutting stone is a natural formation, and although it can be reset many times, it cannot be sharpened. In resetting, the stone is taken out of the mounting, and reset at a different angle. These stones have from one to four cutting points, and after it has been reset two or three times, using the same point, it is then necessary to find a new point. Drills are made of splints, which are obtained by cleaving large stones, or from natural stones, sharpened or lapped, by hand. These can be resharpened a number of times, and should be kept sharp to do quick work. The bench should be equipped with a buff-head, having a taper screw and chuck, for small drills, burrs, polishing wheels, etc. As these are not furnished with the outfit, and they must be selected separately, we would recommend the following: About six small twist drills, of different sizes, including the size for frameless glass screws and stud screws; two sizes of solder burrs, for burring out eye wire after soldering; two sizes of temple burrs for burring the joints of temples; a brush wheel; a felt wheel, about three or four inches diameter, will do; a cotton wheel, about six inches diameter. This outfit will do all the work you are required to do.

Next is the motor, and the first thing to do is to inquire of the power company what the current is. It probably will be either direct, 110 volts, or alternating, 110 volts, 60 cycles, and in asking for quotation, or ordering an outfit from the jobber, be sure and give this information, as it makes about twelve or fifteen dollars' difference in price. All quotations are given with direct current, and the alternating costs extra. If you have a direct current, a ¼ h. p. shunt-wound motor should be used. This maintains its speed without the load, while a series-wound will speed up and the

load must be kept on to hold it down. You should see that you get a quiet one, as a magnetic hum is very disagreeable. There is a rheostat, or starting box, furnished with it, and if the outfit is bought complete it will be wired up on the bench with a switch and cut-out. It is only necessary then for the electrician to connect the wires, and you are ready to start.

If you have alternating current, we should recommend an automatic starting, ¼ h. p. This requires no starting box, which

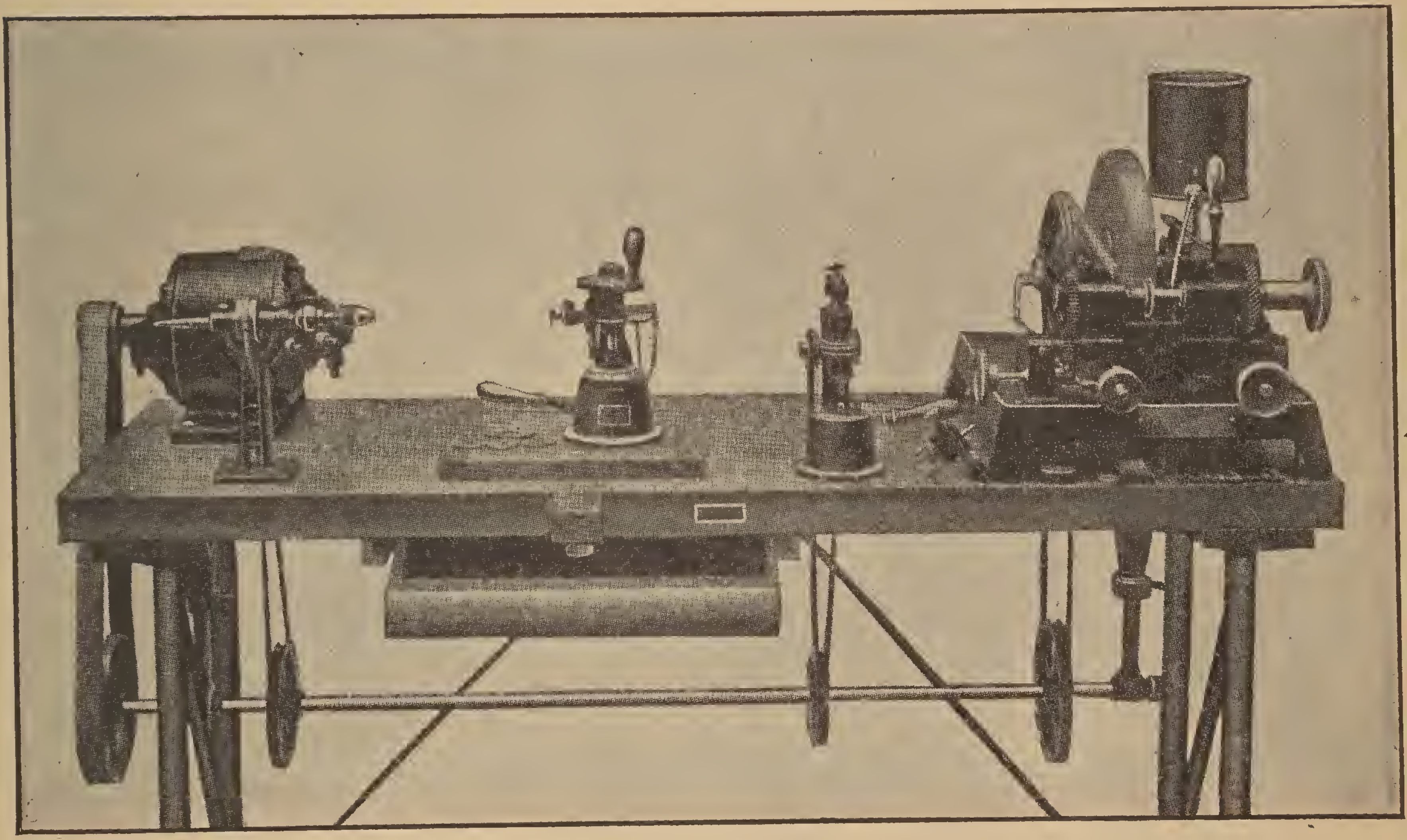

Fig. 3—A modern optician's workbench

is quite large for this current, and is also started quicker. In buying a motor, the speed is an important matter, and many of the shops that have been fitted up by opticians themselves are equipped with high-speed motors. These have been installed, either from inexperience, or on account of the low price. A slow speed motor runs with less noise and there is less slipping of the belts. Then again you do not require such large pulleys. They are, of course, higher in price, but are worth the difference. In belting up the motor, an endless belt should be used, so there will be no pounding

of the lacing and no vibration. This is very important, if you want a smooth running outfit.

We have now given you a general idea of the outfit, and we think you will see that it is a great deal better to purchase this complete and obtain the benefit of the experience of the optical machinery manufacturers. They have made a study of shop troubles, and have succeeded in eliminating many of them. Occasionally you find an optician who has built his own bench, with the idea of saving money, but in the end he finds it has cost more than any first-class outfit on the market.

Now in regard to tools. These, of course, are not furnished. You will need the following: A pair of breaking tongs, cribbers, a hand-diamond, a set of the brass patterns for cutting odd lenses, round-nose pliers, snipe-nose pliers, optician's hollow chop pliers; flat-nose pliers, strap pliers, angling pliers, cutting pliers (and as there are plenty of special pliers on the market we would suggest looking them over and getting a few of the best ones); an assortment of files, including rat-tail; a millimeter rule; broaches, drilling fluid, bifocal cement and polishing material.

This covers most of the necessary tools, and can be added to as occasion requires. When the outfit comes to you, it will be crated, and after it is opened up, set in place and connected with the current, it should be wiped up to take off the grease which is put on to keep it from rusting in transit. Then look at the bearings, especially the boxes on the stone and main shaft. These may have been set up tight in shipping. If so, the screws should be loosened a little until they turn freely.

Everything should then be well oiled and then the motor can be started. It should be run a few hours, feeling the bearings occasionally to see that they do not warm up. If so, they should be loosened up a little more. Possibly the belts may be a little loose, and even if they are all right at first they will have to be shortened later, as all new belts will stretch. If the motor is a good one it will have an adjustable base, so that it can be adjusted to take up the slack. After taking up all you can in this way, have a piece taken out at some belt manufacturer's, and do not attempt to lace it. All other flat belts will be laced, however, and these you can take up yourself, but always use light, thin lacings to make it run as smoothly as possible. The round belts will probably be put together with hooks, and they will require shortening

very often. In shortening belts do not get them too tight; it is better to run them a little loose, and if they slip it is probably because they are too hard and dry. By applying a little castor oil, occasionally, on the inside, while it is running, it will make them soft and pliable. Never use resin or anything of that nature.

After everything is running smoothly, you can then put water on the stone and place some thick lenses in the machine and allow them to grind a while. In starting a new composition stone, it

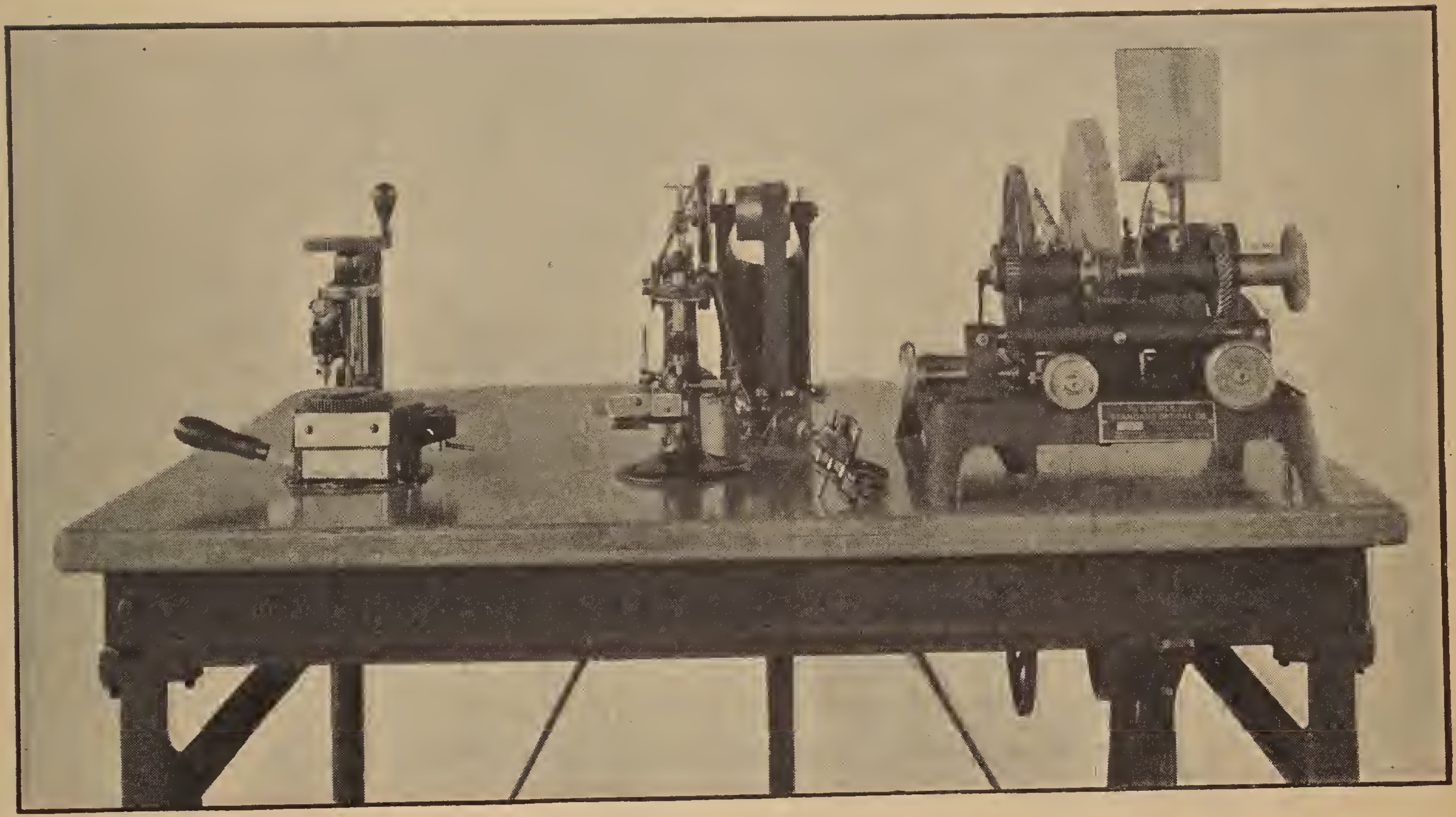

Fig. 4—Outfit for prescription work

will absorb the water very quickly, and for the first hour or so watch it carefully and see that it does not run dry, as this will rough it up and may require turning. The stone can be kept wet by a drip, either from a tank, or it can be connected with the water supply, but you should then arrange for the outlet, or it is liable to overflow. A very popular way is to have a sponge pan on the back, filled with water, and the sponge will act as a wick, keeping just enough water on the stone. Some of the machines are supplied with this sponge pan and we recommend this method, as it is much cleaner. Some of the stones, shipped from the factory, are

not quite ready to grind on, but by running thick lenses in the machine for a while it will smooth up very quickly. If it does not, a piece of the same material, held by the hand, will polish it.

All the frameless machines are equipped with truing devices, and it is well to true the stone up every little while to keep it in perfect condition, rather than allow it to get badly out, as it is then quite a job to get it back. All that is necessary to do is to set the truing device up until the carborundum stone just touches the grindstone and allow it to run a few minutes until you cannot hear it grind. As the stone oscillates it trues itself automatically. If your stone, for any reason, should get badly out of true, you should turn it with a carbon or black diamond, or you can use the new tool on the market similar to a carbon. This is placed in the truing device and operated the same as the carborundum block. After you have turned it true, it will be very rough; then by replacing the carborundum you can smooth it, the same as before described.

We will describe the use of the drill and cutter later, but they can be tried, and if they do not suit have them exchanged at once, as they are not guaranteed. Do not spoil them and then claim they were never right. If you do not get good results in cutting, it is probably because you have not used just the right pressure. Start lightly, and on each lens gradually increase the pressure until you get a good clean cut.

The cost of operating is trifling, as a ¼ h. p. motor uses very little current, costing not over one dollar a month.

The accompanying illustrations will give an idea of the arrangement of the benches most in use.

CHAPTER II

Lenses—Marking and Cutting

In selecting the stock of lenses quite a little capital can be invested, or you can start small and increase it from day to day. A stock varies in price from $50 to $500, but the usual amount invested is from $100 to $200. This will include principally + ⊃ + compounds, a few — ⊃ —, plano cylinders, oval or round Dcx. and Dcc. sphericals, Pcx. sphericals, regular and plano wafers. If you use large, full eye lenses it will be better to have the sphericals in round, as these will grind 40 mm. or 41 mm. in length and any width. The + ⊃ — and — ⊃ + compounds, compound wafers and rough cylinders (provided you are to do surface grinding), can be ordered daily, until you can afford to stock them.

Compounds are put up in single envelopes, with the axes dotted, cylinders in packages of half dozen pairs, the axes dotted, and sphericals in the same way, but not dotted. By this you will see that it is better to buy cylinders and sphericals in original packages, although compounds can be ordered three pairs of a number. If you have had no previous experience in ordering, a good plan is to see your jobbers and tell them that you wish to place an order for a quantity of rough lenses, stating the amount you wish to invest, and let them submit lens sheets, showing the assortment and quantities that can be obtained for this figure. As they are constantly making them up, they can best advise you. You can then look it over and change it as you see fit. If you have made no provision for carrying your stock, we would suggest getting an uncut lens cabinet. This is made of oak, with galvanized iron drawers, with wood front and back. The small drawers are partitioned off for compounds and the large for cylinders and sphericals. The latter have pressed paper partitions in front for single lenses, without wrappers, and the surplus is placed in the rear. This can be obtained much cheaper than you can have one made and will last a great many years.

A good way to keep your stock ordered up is to have a box

handy, and as you use the compounds put the envelopes into it and order from them.

In selecting the lenses for a prescription it will be necessary to have a pair of calipers or lens gage, graduated in 1/5 mm. With this the lenses are calipered in the center, allowing 2/5 mm. for each diopter. For example, a plano lens is the same thickness on the edge as in the center, and if you wish to make a pair of glasses two-strap thickness, having a plano in one eye and + 1 in the other, we select the plano first 2 mm. thickness and the + 1, 2 2/5 in the center. If the lens was concave, it would be 1 3/5 mm. In this way the edges are made the same thickness. In cases where there is to be a compound in one eye and spherical in the other, it is well to look at the compound and use your judgment

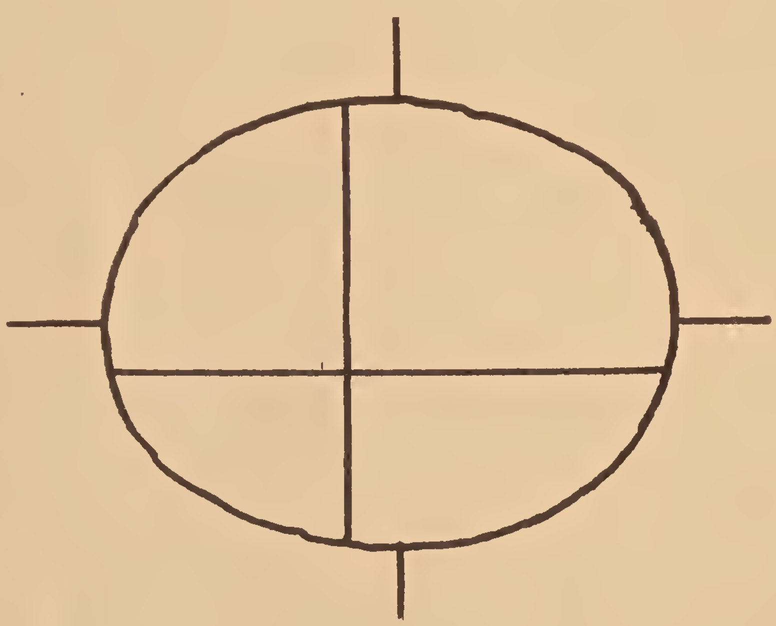

Fig. 5

as to which would be best---a double convex or periscopic. If the compound is + ⊃ +, a Dcx. would make a better match; whereas if it were + ⊃ —, a Pcx. would be nearer the curve.

For marking you will need quite a stiff pen that does not scratch, a bottle of black waterproof ink and a protractor graduated in five degrees. These are furnished by some jobbers, as advertisements, with a decentering scale on the back, which is very convenient. For cross lines use a card about the size of a reading test type, and draw heavy black lines at 90° and 180°. This will be used for medium and strong powers; for the weak powers draw the lines on a wall about twenty feet distant. In marking, first decide which surface will be next the eye and then always mark on this surface. The rule is, the greatest

concavity or the least convexity, next to the eye, always having the cylinders on the same side, except in extreme cases. We will first select a sphere, and all that is necessary in this case is to dot

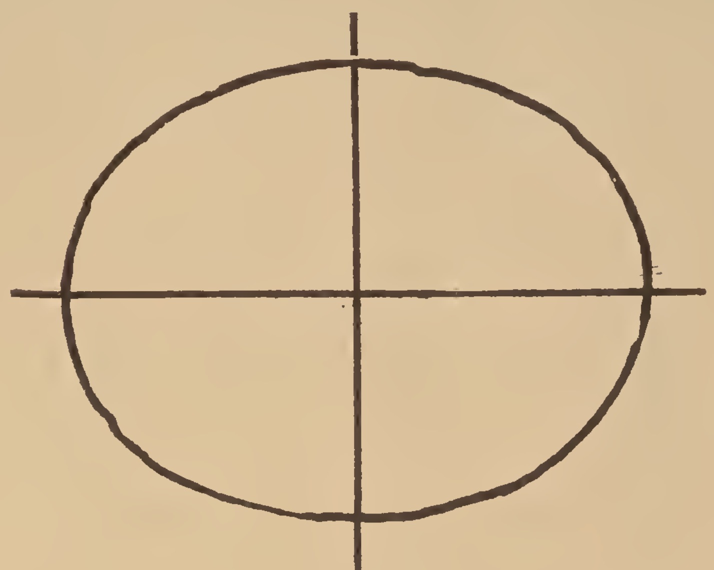

Fig. 6

the center. We find the center by looking through the lens at crossed lines, and the lines will appear broken (Fig. 5).

Then move the lens until the lines are continuous and place a

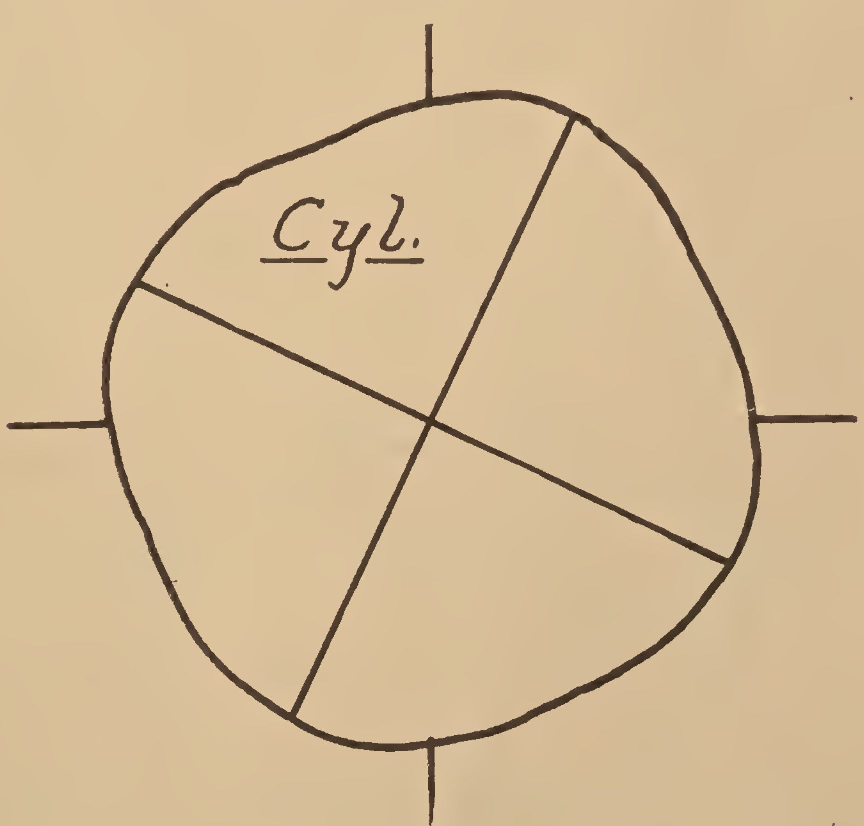

Fig. 7

dot where the lines cross (Fig. 6). A cylinder usually has the axis running from corner to corner, and in lining it up the lines will appear broken and perhaps twisted (Fig. 7). By turning the lens they will line up so that they appear straight and by moving

in a horizontal and vertical position they will be continuous. Then place two dots on the lens, one at the top and one at the bottom. Now lay it on the protractor with these dots at whatever axis the lens is to be cut. Draw a line across the lens at axis 180°. This

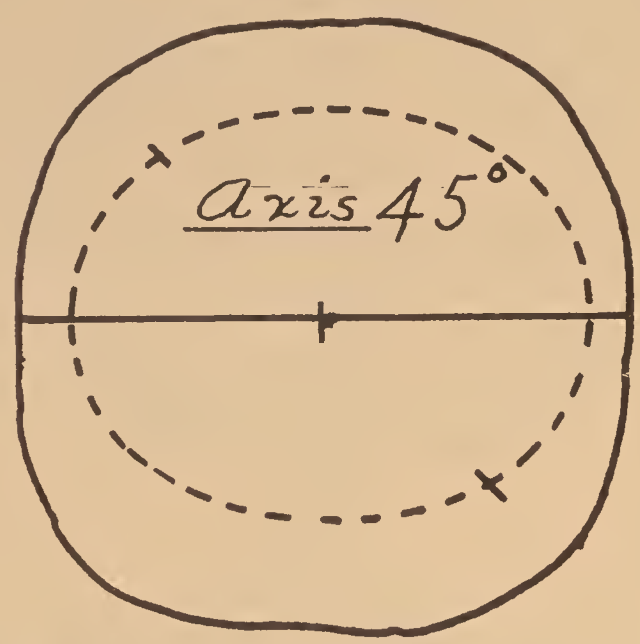

Fig. 8

will be the mechanical axis or cutting line, as it is usually called. Remember that whatever axis is to be cut the cutting line is always drawn at 180°. For example, axis 45° will be placed, as shown in Fig. 8, axis 90° as Fig. 9.

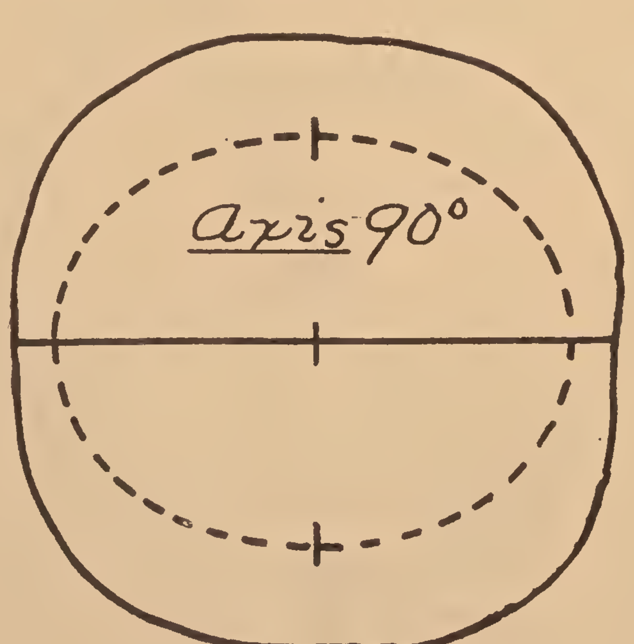

Fig. 9

A compound is lined up in the same way as a cylinder, and the lines will look the same, but when you have it in position three dots must be placed on the lens, one at the top, one at the bottom and one in the center. It is then laid on the protractor the same

way, but be sure that the center dot is on the center of the chart or your lens will be decentered. If you wish to obtain some prismatic power you can decenter it, using the following rule: A lens decentered ten millimeters will produce a prism power of as many diopters as the focus. Thus a + 1 D. lens, decentered 10 mm., will have a prism power of 1 D. By this you will see that a +

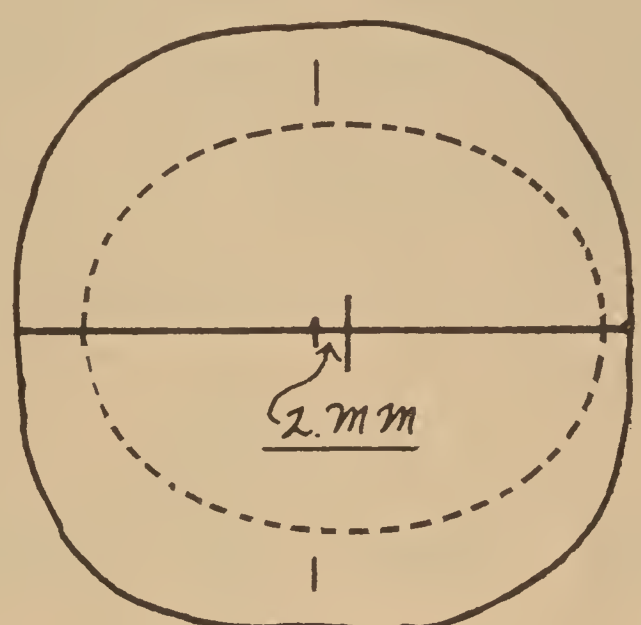

Fig. 10

1 D. lens, decentered, 2.5 mm., would give us ¼ D. prism. A mistake is often made, however, in ordering a lens decentered 6 or 8 mm. This cannot be done, as the stock lenses are not large enough. Extra large lenses could be used, but these would cost more than to have a pair surface ground. With the large sizes

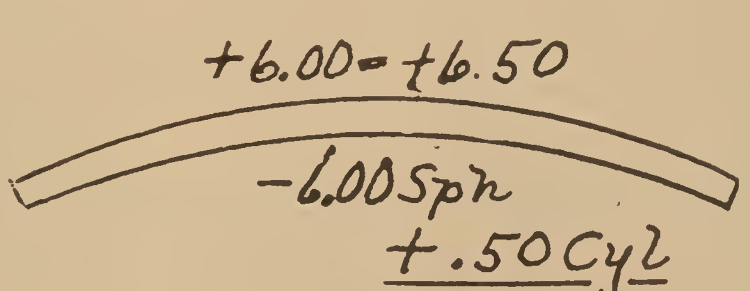

Fig. 11

that are now being used a lens cannot be decentered over 2 mm. In marking a lens to be decentered, it is dotted in the usual way and then moved on the chart the amount necessary and a cross line drawn on the cutting line (Fig. 10). Before the lenses are cut they should be neutralized to be sure the power is correct. If you depend on the lens measure it should be kept accurate by frequent adjusting, and if you do not have two, one for American

Optical Company and one for Bausch & Lomb, you should make an allowance of .03 D. for every diopter. We prefer to use a lens measure, graduated for Bausch & Lomb stock, and then add the required amount when measuring American Optical Company's stock.

We will not describe the marking of prisms, as we should recommend that they be sent to the prescription houses. Very little can be saved in buying them uncut, and the responsibility of breaking is too great. This also applies to torics, but if you prefer to grind these yourself they are handled just the same as flat lenses in marking. We will give a few suggestions for ordering, so that you will be sure to get the best results. If all prescriptions for torics were filled as written a great many would have no toric effect.

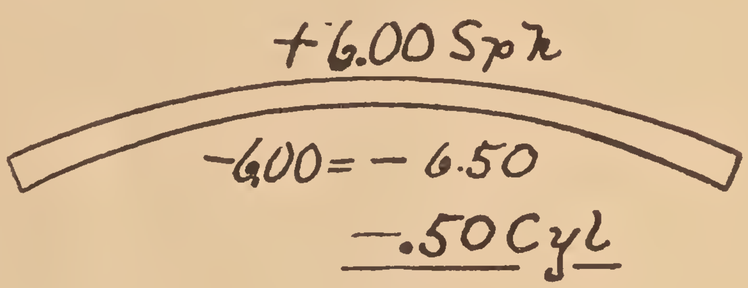

Fig. 12

You should, of course, understand the transposition of lenses, and transpose them to the best form before sending in the prescription. If you do not you should state that you want the prescription filled in the best form. In ordering plain cylinders it will make no difference which way they are ordered, unless wafers are to be fitted. If a + cylinder was ordered, the lens would be ground as written and would have the cylinder on the outside, and a 6 D. curve on the inside (Fig. 11). If a — cylinder was ordered it would be ground with the cylinder on the inside and a + 6 D. curve on the outside (Fig. 12). If wafers were to be fitted, the cylinder should be on the outside, so that the wafers could be cemented to the inside surface. It would then be necessary to transpose to a compound. For example: A — .50 cylinder, axis 180°, would be .50 sphere ⊃ + .50 cylinder, axis 90°. This lens would, of course, cost extra.

The ordering of compounds is a more difficult matter and the optician should know just what surfaces are to be ground. For example: If a + 1 sphere ⊃ + .50 cylinder, axis 90°, was ordered, it would be ground as written, and the lens would be

+ 6 ○ + 6.50 on the outside and a — 5 sphere on the inside (Fig. 13).

By this you will see that the toric effect has been reduced 1 D. While it does not matter much in this case, the toric effect is

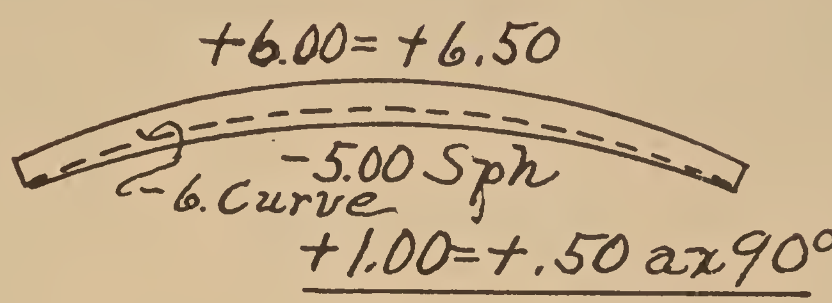

Fig. 13

gradually reduced until with a combination of + 6 sphere ○ + .50 cylinder, axis 90°, it has a plano effect and this would be ground with + 6 ○ + 6.50 on the outside and plano on the inside (Fig. 14).

All + and + combinations with a spherical stronger than + 1 should be transposed. For example: + 3 sphere ○ + 1 cylinder, axis 90°; if ground as written, would have only — 3 D. inside curve. If it is transposed it would be ground with + 10 D. outside and — 6 ○ — 7 inside (Fig. 15). This lens costs more, but will give better satisfaction to your customer. If you

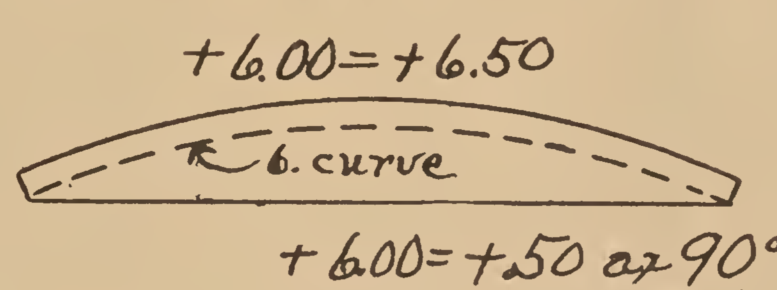

Fig. 14

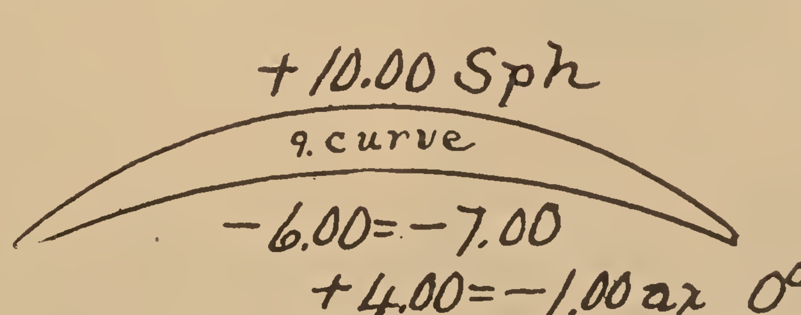

Fig. 15

understand this before ordering you can explain it to your customer and charge more for your lens accordingly. Concave com-

binations are transposed in the same way. When wafers are to be fitted they should be transposed so that the cylinders are on the outside.

In combinations where the spherical power exceeds + 3, the distance lenses should be ordered on a + 9 curve. Thus a combination + 3 sphere ⌒ + 1 cylinder would be + 9 ⌒ 10 on the outside and — 6 sphere on the inside (Fig. 16). This gives you

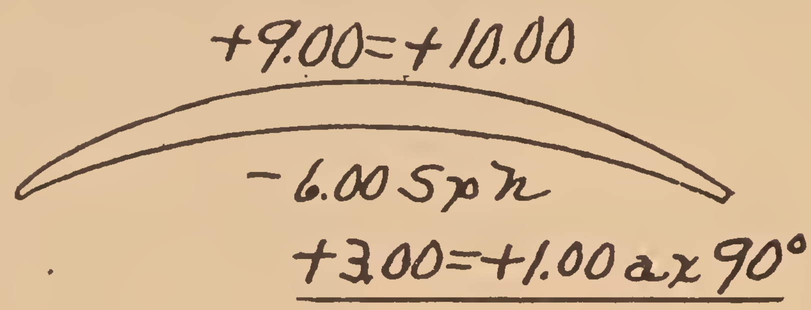

Fig. 16

the regular — 6 toric effect, and although it increases the expense it makes a much better lens.

In selecting stock for bifocals the upper lenses are marked as usual with one exception, and that is, the wafers are always placed on the inside when possible. For sphericals, periscopic lenses are used for the uppers and "regular" wafers are cemented on the inside. For example: Prescription distance + 2; reading + 4, select + 2 Pcx. and a "regular" wafer, having a + 2 power, which is the necessary addition for reading. This will be + 1.25

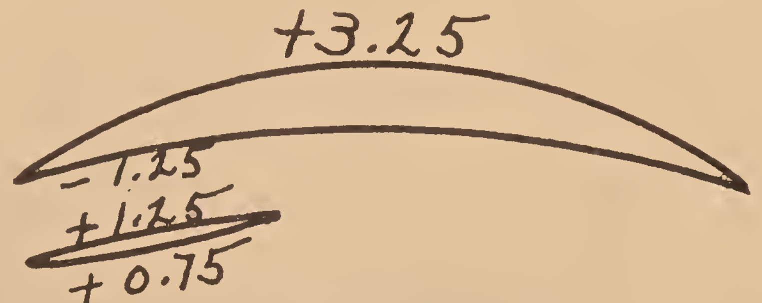

Fig. 17

on one side and + .75 on the other. The + 1.25 side is cemented to the — 1.25 curve on the upper lens. The + .75 on the outside of the wafer and the + 3.25 on the outside of the upper lens will then give us the required focus (Fig. 17). The contact surfaces are not considered in any way, other than that they must fit perfectly as they have nothing whatever to do with the focus of the lens when the index of the glass is the same. If

it is different, as in fused bifocals, it is then an important matter, and must be taken into consideration.

For cylinders plano wafers are used and cemented on the plano side. You will have no trouble with these, as the power of the wafer is all on one side. Be careful, however, never to cement a wafer on a cylinder surface, as the cylinder effect is then destroyed. Compounds are a little more difficult, but are simple when understood. The wafer is usually placed on the inside in weak combinations. The only reason for this is to make them more invisible. Whichever way they are made the wafer will have to be cemented to the spherical surface, and here is where you will, perhaps, be confused in marking. Be sure that you lay the

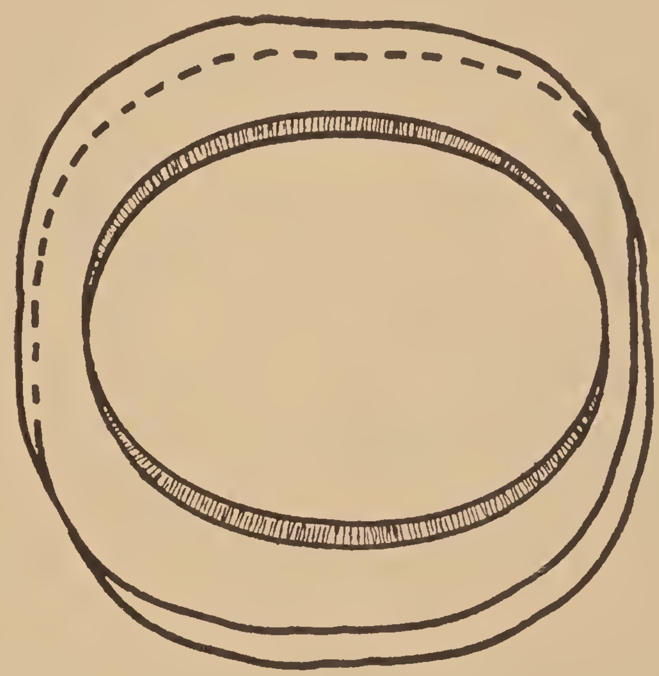

Fig. 18

lens on the protractor, with the surface upward, that is, to be next the eye. If the spherical is to be *in,* mark it on the spherical side. If the cylinder is *in,* mark on the cylinder side. You can readily see that if the axis is to be 45, with the cylinder surface out, and you mark it on the cylinder side, and then turn it over, the axis will be 135°. In selecting the wafers the contact surface will be the same power as the spherical surface on the compound, but the curve will be the reverse. To this power add the amount to be added for reading and you will have the outside surface. For example: Prescription + 1 ⊂ + .50, axis 90°, distance add + 2 for reading. We will first select — 1 to fit the + 1 surface, and by adding the + 2 for reading we have + 3. Then the wafer wanted is — 1 ⊂ + 3.

You should first become familiar with the working of your machine. Read the directions and be sure that you understand how to set it for size. Some of them are set by charts. That is, for length and width. Others are set by the difference between the length and width. In other words, the patterns are marked from 4 to 12, so that 40 x 33 would require No. 7 pattern, and the gage is set at the length, 40 mm. In cutting for frameless, allow 1 mm. on the length and width. For above size it should be cut 41 x 34. For frame size, it is best to cut a lens and try it in the frame, allowing about ⅛ to 3/16 inches between the end piece,

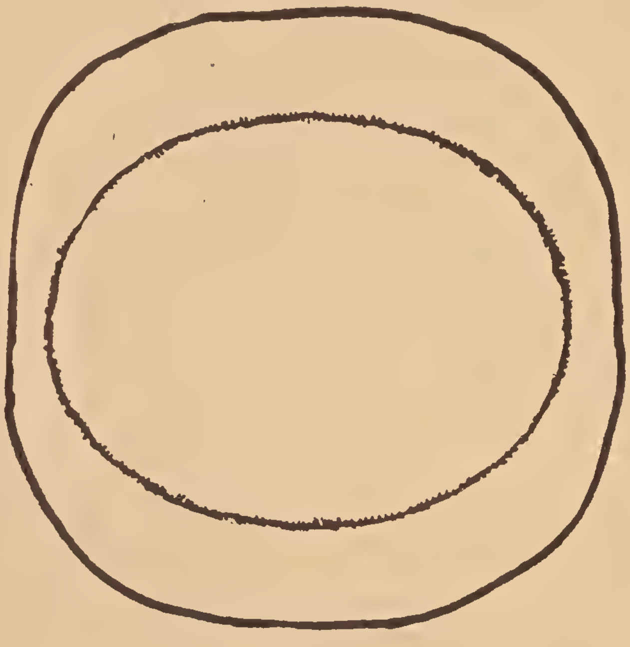

Fig. 19

according to the thickness. After you have ground one or two, you can judge for yourself just the amount you will need for grinding.

When the machine is in position to cut the handle on the top gear should be at the right. It should always be turned to the left, making one revolution, and stopping at just the point where it started to cut. *Never, under any circumstances, run by this point, as you will spoil the diamond.* If, for any reason, you do not get a satisfactory cut it is better to turn it over and try again on the other side. In placing the lens on the pad see that it fits perfectly flat and does not rock. If you have a universal pad it will be all right; but if your machine has a number of pads select the one nearest the curve of the lens. Also cut on the surface having the least power on the nearest to plano. In laying the lens on the pad, the cutting line should be on the 180° line on

the cutter, with the center on or under the centering pin, whichever way the machine is constructed. When the lens is in position, raise it to the diamond by pressing the hand lever on the left side. Start gently at first, increasing the pressure gradually, turning the lens slowly at the same time. Some diamonds require more pressure than others, but you must experiment carefully until you find that you get a perfect cut (Fig. 18). This you will see has a sharp line which runs almost through the lens. If you put too much pressure on it you will have a scratch (Fig. 19). This lens you will find very difficult to break down, and probably break over the mark, unless you are extremely careful.

There is another way to cut a lens without marking and in this way you turn the pad in the machine so that the line corresponds to whatever axis you are to cut on the graduated scale. The lens is then placed with the axis dots on the line on the pad. This will give you the same result, and, although it saves time, it is not so accurate. Strong lenses and high curve torics can be cut better by hand. These are marked in the same way, selecting a brass pattern the exact size of the frame or the dimensions of the frameless lens to be ground. Lay this on the lens with the three holes over the dots, or on the cutting line, holding it in the left hand with your thumb on the pattern. Use the diamond in the right hand in a vertical position, the same as a pencil, or with the handle between the index and third fingers. Cut lightly around the pattern and be careful not to run over the line.

In breaking down, start at the end of the lens and crumble off the glass until you reach the cut. If it is cut well you can then grip the glass on the side and you will find that it will break off easily. If you do not get a good cut break off a little at a time with the breaking tongs, and after you have gone all the way round you will, perhaps, have left a number of points. Then take the cribbers, using them as a pair of scissors, and trim it up. This tool is one of the most difficult to master, but by persevering you will soon learn.

CHAPTER III

Lens Grinding

For hand grinding a large stone is preferable, and the size most commonly used is 24 inches diameter by 1½ inches face. Craigleith, corundum or carborundum can be used, but the corundum, called by the trade name Alundum, is the best. This size should run at about 225 revolutions, or 1415 feet per minute. To obtain the proper speed for any size stone, multiply the diameter by 3 1/7, and then multiply by the number of revolutions desired.

The stone should turn away from the grinder and should be kept wet by a drip or sponge on the back. It is unnecessary to have a great amount of water on the stone, so that it will fly all over everything, but keep it just wet enough so that it will not run dry. With ordinary care the stone will keep in shape, but if it becomes rough it should be smoothed with a piece of the same material. Do not use a piece of craigleith on an alundum, or *vice versa.*

The turning can be done by hand, but not as well. When turning without a truing device the diamond is held in the right hand and the left is used to steady and guide it. A board is placed on the trough at the back, so that it just clears the stone; this is used as a rest. The diamond tool is then started at either edge and rolled along, so to speak, on the rest, so that the stone is cut evenly. Enough should be taken off so that the surface is square and true. A carborundum block should then be used on the back to smooth it, or, in other words, take out the ridges left by the diamond. The stone should then be honed with a piece of the same material, held in the hands, on the front.

When the lenses are cut and ready to be ground, they should be rinsed in water to remove all the glass dust, otherwise this gets into the fingers, and as the lens is revolved, it scratches the surface. In large shops there is apt to be quite a little waste from scratching; and this is usually the cause. A rubber coin pad, such as are often seen on counters, and which can be obtained in any

rubber store, is convenient to lay lenses on, and prevents scratching.

If the lenses are well shaped with the cribbers, there is very little difficulty in putting on the level, but if there are bunches and points to be ground off, this is where skill is required. The shaping is the first important point, and the eye should be trained to judge ovals. The axis should also be watched at the same time

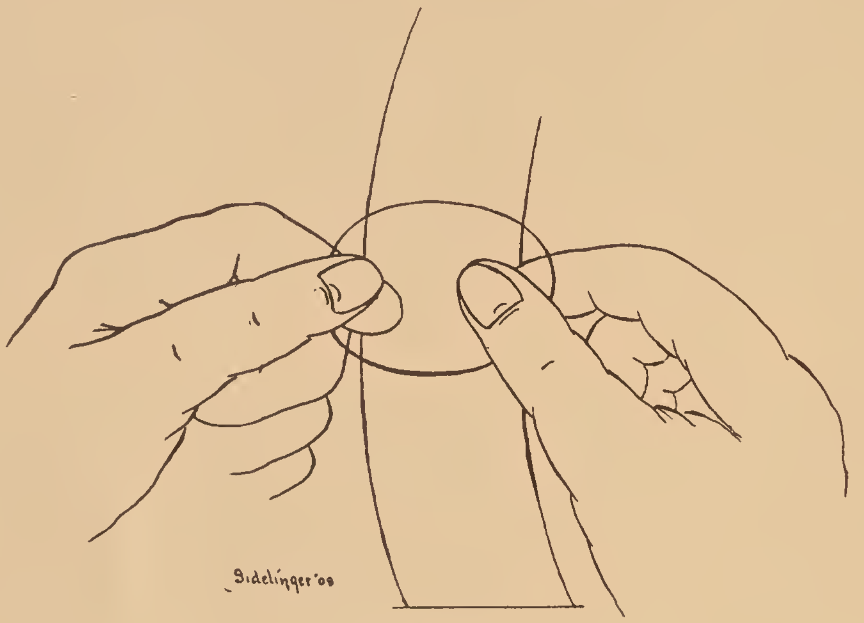

Fig. 20

and see that you do not grind it off. If the lens is cut large, and this very often happens, it is a good plan to mark it occasionally.

In shaping the lens, it should be held between the thumb and forefinger of both hands (Fig. 20) at a slight angle, turning it from left to right. The points and bunches should be taken off until you have a good oval. The lens should then be held between the thumb of the right hand and the forefinger of the left (Fig. 21). It should then be revolved with the forefinger of the right hand as far as possible and then picked up with the thumb of the left until you can get another hold with the forefinger of the right hand. In this way the lens can be revolved as steadily as if it were in a machine. If you have trouble with the lens sticking to your fingers, a little piece of soap can be kept handy, and by just touching it occasionally you will avoid this annoyance.

The lens should be beveled a little first on one side, then turned over and ground the same amount on the other. Too much pressure should not be used, as it is better not to try to grind too fast. As soon as the lens is beveled on both sides, it should be tried in the frame for size. The screw should be taken out and

the temple removed, and to bring the joints together, an old pair of cutting pliers having the edges drilled should be used.

As the lens is tried in the frame, you should learn to judge the amount it will be necessary to grind off. In any case, however, the lens should be tried frequently, so that it will not be ground too small. It should be fitted so that the joints just come together, and no light can be seen between them with the lens perfectly tight, and as the joints are held with the pliers in the right hand, try to twist the lens with the left. The level should be perfectly smooth, and equal on both sides, with no chips or bright places; if it does not come out this way the lens was cut too small. Just before trying the last time, the lens should be held in the right hand between the thumb and forefinger in a vertical position, and allowed to turn on the stone a couple of times to take off the sharp edge, otherwise it will chip when the joints are screwed up.

When the lens is placed in the frame see that the strongest concave, or weakest convex surface, is next the eye, so that the axis will be right (the lens should have been cut this way). Also see that the ends of the lens come to the center of the joints and foot of the bridge. Never mind if the frame is out of shape, put the lens in right and true the frame so that the lenses will be horizontal afterward. In grinding the lens for the other eye care should be used to keep the shape the same.

When grinding torics, coquilles and strong lenses, the frame should be curved slightly to conform with the shape of the lens, otherwise the eye wire will spring off the bevel, causing the lens to drop out. Clerical, or half eyes, are difficult to grind and care should be used to fit the corners well before attempting to reduce the lens to size. After the corners and top are fitted the surplus glass can be ground off the lower part.

Pebbles cannot be ground successfully on an ordinary alundum stone, as special grit is required. Carborundum is the best, but craigleith answers the purpose very well, although it is slow cutting.

Window glass should not be ground on your stone, as this has a tendency to rough it.

Strong lenses require a steeper bevel than the regular, and as the high power convex are thin on the ends and thick on the sides, it is well to start the bevel on the sides first and grind the ends last, otherwise the lens will be too full.

In fitting lenses to rubber or zylonite frames, the frames should be softened in hot water or over a gas flame. Extreme care must be used not to burn the frame. Shell should never be attempted, as these are very brittle and are costly to repair. When fitting lenses to metal lorgnettes, it is advisable to cover the handle with tissue paper or cloth to prevent scratching. We advise,

Fig. 21

however, that these difficult jobs be sent to the prescription houses, as it is often expensive to repair or replace these frames should they become damaged or broken.

For hand grinding the lens is cut ½ mm. larger all around, and the first operation is to shape it. It is held in the center between the thumb and forefinger of the right hand in a vertical position. The left thumb and forefinger are used as a rest and guide (Fig. 22). The points and bunches are then ground off until you have a true oval. The lens is then held in the same position, but allowed to revolve slowly. This is done by pressing gently against the stone and allowing the lens to slip between the fingers in the right hand; the left is simply to steady and guide it.

Care should be taken not to let it get away from you, but with a little practice it can be revolved as steadily as a machine.

After the lens is down to size and the edge is flat and smooth, the sharp edge should be taken off, or, in other words, put on a very small bevel. Strong lenses and torics will require more

Fig. 22

bevel where the straps are fitted to prevent chipping. In this operation the lens is held in the same position as in grinding lenses for frame (Fig. 21). If a new pair of lenses is being ground they should be measured in millimeters for length and width. The sizes are as follows: 1 eye, 37 x 28; 0 eye, 38½ x 29½; 00 eye, 40 x 31; 000 eye, 41 x 32; 0000 eye, 44 x 30. Full eyes or short ovals are the same length, but two (2) mm. wider.

For measuring, a millimeter rule is considered accurate care must be used not to burn the frame. Shell should never be enough, but if yoú wish to be exact, a Boley gage is better. In matching a broken lens, you can lay the new one over the old one and judge the size, but this requires practice. The shape should also be noted as it is possible to grind two lenses having the same length and width, but the shape will be different, one may have

full corners (Fig. 23) and the other pointed (Fig. 24). Some prefer the shape with full corners, as it gives a straighter surface for the strap to bear against, and, consequently, does not loosen as easily.

Drop eye lenses (designated by various trade names in different parts of the country) are ground in the same manner. These are ground off axis very easily, so this point should be looked out for. Also see that the ends are not ground too quickly, as the shape will lose its identity and the results will be more like a regular oval.

For machine the lens should be cut a little larger than for hand grinding, usually about 1 mm. all around is allowed. The marked places on the lenses for cutting are used to center the

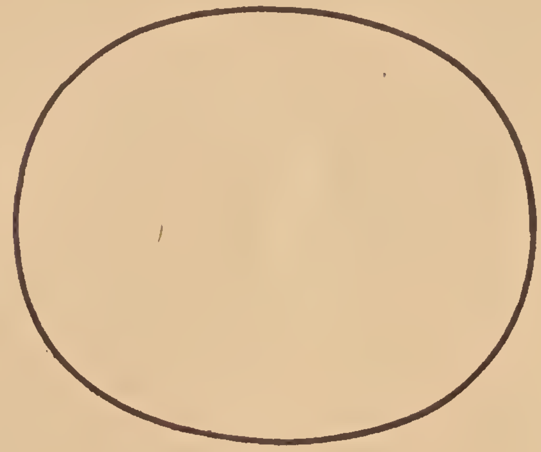

Fig. 23

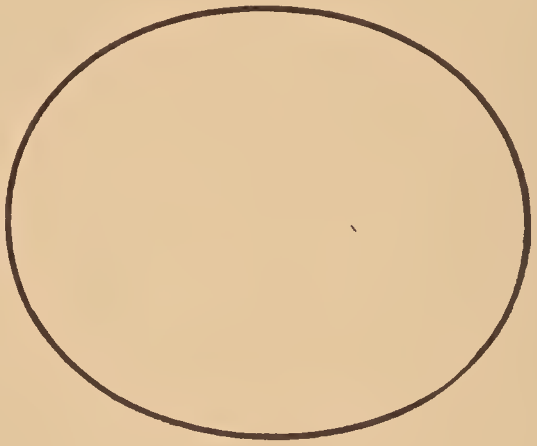

Fig. 24

lenses in the machine. The lenses are placed in the centering device with the cutting lines, together with a piece of rubber or wet cardboard between them to keep them from slipping. Extreme care must be used to see that these are placed on the pads just right so that the axes and centers will be perfect. A little slip at this point will spoil your lenses.

For size subtract the width from the length and the difference will indicate the number of the pattern to be used. This is placed in the machine and the gage set to the length required. For example, to grind 40 x 31, the difference is 9. Fit this pattern and set the pointer to 40 mm.

After the lenses are in position start the machine and let the lenses down to the stone. Do not put much tension on the spring until the lenses have revolved two or three times, taking off the roughness. As soon as the sharp points are ground off the tension can be increased so that they will grind faster.

The tension should also be regulated according to the number of lenses grinding at a time. If too much is used for a single lens it will chip. The time necessary to grind a pair of lenses will vary from four to ten minutes, depending on the thickness and the amount allowed for grinding. Plenty of time should be given, however, because if they are removed before they are finished, the shape will be irregular. You can easily tell when they are finished by the sound. It is unnecessary to remove them immediately, however, as they can grind no smaller than the gage. After they are ground to size they must be removed and the sharp edges taken off the same as if ground by hand.

When the lenses are removed from the machine, they should be wiped immediately, or the grindstone grit is apt to dry on the surface, and when cleaned off it leaves marks resembling scratches. These are very difficult to remove, but they will come off with a wet cloth and fine pulverized pumice.

Lenses can be edged in the machine without cutting if desired, but this is of no advantage unless grinding for stock. Some opticians prefer to use their machines this way rather than allow them to stand idle, but there is no advantage in it, as interchangeable lenses can be obtained of the jobbers at about the same cost.

The greatest difficulty experienced in grinding by machine is the slipping of the lenses. This is caused by the pads becoming soft and greasy. It is a good idea when through with the machine for the day to place a piece of blotting paper between them to absorb the moisture and prevent sticking.

When placing concave lenses in the machine make sure that the pads between the lenses are thick enough, otherwise the edges will touch, causing them to crack.

If flat places or lines, called facets, are found on the edge, the stone is out of true and should be turned immediately.

Some prefer to use the frameless machine without a pattern, and when grinding this way the lenses must be watched to see that they are not ground too small. This method is perhaps quicker, but the machine requires constant attention.

In cutting, twice as much should be allowed on the ends as on the sides (unless your machine has a compensating device). For example, to grind 40 x 31, the lens should be cut 41 x 31½.

Providing you do grind nearly all your lenses by pattern, it is often convenient to match odd or special shapes by this method.

CHAPTER IV

Drilling and Mounting

Glass can be drilled in various ways, either with a hand drill or with power; with steel point or diamond; in an upright drill or in a lathe.

For drilling, a diamond is recommended, and this can be obtained in a white splint, carbon (black diamond), white turned diamond, or a turned carbon. A white splint costs about five dollars, although a better one can be obtained from six to eight dollars; carbon about ten dollars; white turned diamond about twelve dollars; turned carbon from fifteen to eighteen dollars. We recommend, however, the best white splint, as it has a rough point and cuts faster. It can also be sharpened at a less expense. Turned diamonds do not cut as fast, but are less liable to break. By using care, however, one need never break any diamond.

A diamond drill should run at from 1600 to 2200 revolutions per minute, but 1800 is recommended. If it runs too fast, it throws the lubricant out of the hole, and, consequently, runs dry. If it runs too slow, too much pressure is required. These two points are really the cause of all breakage.

Before starting to drill, see that the stop is set so that the drill point just clears the pin on which the lens is placed. There should be just space enough to slip a card easily under the drill point. The gage should also be set so that the hole will be the right distance from the edge. For regular flat lenses this distance is .093. Strong convex lenses will be drilled farther in, and strong concave lenses nearer the edge.

All lenses should be drilled, however, for a snug fit and then broached or filed the least bit for the variations of the strap. The most accurate way is to try the strap on the lens and mark it in the screw hole with ink, or better still, with a sharp steel point. (This can be made from an old rat tail file.) In most of the large shops the drills are arranged so that the pressure is applied by foot power, thereby allowing the use of both hands. This can be arranged very easily by drilling a hole through the bench and

attaching a wire to a foot pedal on the floor. After a little practice it will be found that the foot is just as sensitive as the hand.

There are a great many drilling fluids on the market, and, as these are cheap, we would recommend using one of them rather than going to the trouble of making it. The theory of a lubricant is to keep the drill cool, and in lapidaries water is used on diamond drills for drilling all kinds of stones. Turpentine, however, is supposed to soften glass, and for this reason it is used principally in making these preparations; "3 in 1 oil" is also used very successfully by many opticians. If you have an up-to-date drill, with a centering device, you will set the gage and place the lens in position between the four pins, apply the lubricant and place a slight pressure on the handle. Do not drill right straight down, however, but raise the drill constantly to allow the lubricant to flow into the hole. If it runs dry it will show a white powder and more fluid must be applied. This is the most particular point in drilling and must be watched constantly. The breaking of a drill is usually due to carelessness.

If you find that the lens has a tendency to vibrate, the point of the drill is out of true and should be attended to immediately. This is due to the breaking off of a small part of the stone, making the point out of center. This can be sharpened, however, providing the point is not too short. When buying a new drill, be sure that the setting fits the hole in the spindle perfectly. If it is small the set-screw will throw it out of center.

After the lens is drilled half way through, turn it over and drill from the other side. If it is drilled above center it will be necessary to change the gage governing the center device to the opposite side.

Torics cannot be drilled in a regular centering device unless it has a tipping table or other attachment to tilt the lens. If a drill is used without an attachment of this kind, the centering device should be removed and the lens held in the hand. The lens should be tilted up when drilling the concave side, and down on the convex.

Lenses can be drilled just as well without a centering device, but it is necessary to dot the lens. This can be done by the eye, or a separate centering device for marking can be obtained for a small sum.

A steel point will drill just as good a hole as a diamond, but it is necessary to sharpen it after drilling every few holes. A good point can be made from an old rat tail file sharpened to a long point, having two rounded sides. In grinding, however, be careful not to draw the temper. A steel drill should run much slower than a diamond, or from 600 to 800 revolutions per minute. The centering device should not be used, but the lens should be held in the hand, and, instead of being held rigidly, it should be rocked slightly to allow the drill to cut.

After you have drilled both sides of the lens so that the holes meet, it should be broached out. For this purpose a regular four-sided steel broach is used, and is fitted in one end of the idler shaft. These will have to be replaced occasionally, as they become dull and break the lenses. Some drills are supplied with a broach, similar to a rat tail file, but these are used in the same way.

Hand drills are not as satisfactory as power drills, but are used successfully, however, by opticians wishing to drill occasionally and who have no power. We recommend running these by a foot wheel, as better results can be obtained. The great difficulty with these drills is that you cannot get speed enough, and although a slow speed will do for a steel drill, it does not work well with a diamond. When using them, however, more time must be allowed for drilling, as it is not well to force it.

We frequently hear of cases where opticians require from three to five minutes to drill a hole. In cases of this kind there is something wrong; either the speed is not right or else the diamond needs sharpening. If a drill is working right a hole can be drilled in five to ten seconds.

Opticians often make the mistake of using a very long diamond drill. This is not necessary, and they are very liable to break. It is much better to use a short one for all ordinary lenses and have an extra one for thick ones. Do not forget that diamonds are not guaranteed against breakage, and if you get one that is not right, exchange it at once.

For mounting, the following tools are needed: A pair of No. 35 strap pliers, snipe nose pliers, cutting pliers, a rat tail file, glass screw tap, tap holder or pin vise, fine flat file, a screwdriver with a swivel top and a bottle of drilling fluid. Before trying the lens in the strap it will be necessary to remove the screws from

the mountings, and as these are inserted at the factory by machine, they will probably work hard. The screw holes should then be tapped out so that the screws enter easily.

After the holes in the lens are drilled and broached and the studs tapped, the next operation is to try the strap on the lens. If the lens is thinner than the strap it will fit into the bottom of the strap. Notice whether the parts of the strap that bear on the edge conform with the curve of the lens. If not, shape them with the snipe nose pliers. Then take an old tap or a pin about the same size and insert it in the screw hole so that it passes through the glass into the screw hole of the opposite strap. If the lens has been drilled properly, it will be just a little too tight. Now remove the glass and file the hole just a grain toward the edge of the glass with a rat tail file lubricated with drilling fluid. Insert the lens again and try a second time. If an old tap is used it acts the same as a screw, so that when it is screwed into the hole you can easily judge whether it is too tight or not. If it

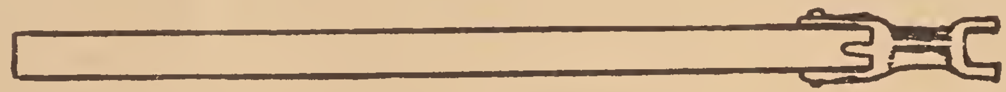

Fig. 25

appears the least bit tight do not try to force it, but remove it and file the hole a little more. For this reason a small metal screw-driver, with a swivel top, is recommended, rather than a wooden handle one, as you do not get such a good purchase on the screw. You can then tell readily if it binds. One of the greatest mistakes is made in forcing screws in the mountings, as this is responsible for most all the breakage.

When the tap enters the hole easily and there is no play, the screw can be inserted, and as it is turned in try the strap and see if it is tight. When a strap is properly fitted it should be possible to twist it sideways just a little until the last turn of the screw, or until it is set up. The last turn should make the snug fit. If the screw turns hard from the start, the hole in the glass should be filed a little more.

We have now taken it for granted that the lens and strap were just the right thickness (Fig. 25). If the strap is too narrow the lens, perhaps, will go in but half way. We then take the strap plier and insert the plain jaw in the strap and the jaw

with the hook on the outside (Fig. 26). With a slight pressure the strap will be widened a little, and if the lens is still tight repeat the operation on the other side of the strap. This operation was formerly done with a snipe nose plier before the inven-

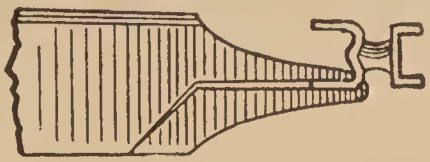

Fig. 26

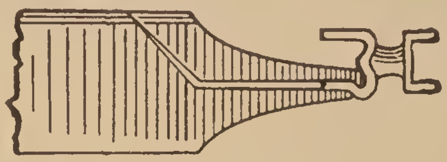

Fig. 27

tion of the strap plier. The great difficulty experienced with this tool was that the straps were thrown out of alignment and it was necessary to square them up and tap them over again. With the strap plier this is not only unnecessary, but the work can be done much more quickly.

If the lens is thinner than the strap the plier is inserted with the hook on the inside and the plain jaw on the outside (Fig. 27). This will make a slight kink in the strap, very close to the lens-bearing parts, which is hardly noticeable. In selecting straps, however, it is best to use one that is a little snug and open it with the strap pliers than to use one that has to be made much narrower. A convex lens is, of course, thicker at the screw hole than at the edge, and for this reason the strap will be made narrower at the bottom (Fig. 28), otherwise it will twist sideways. A concave lens is just the opposite, and the strap should be made narrower at the screw holes with a snipe nose plier. The lens should be inserted on the side at the thinnest part and slipped along to the screw hole. In fitting strong lenses, especially concave, see that there is a good bevel on the edge near the screw hole to prevent flanking.

If the hole has been drilled too near the edge it will be necessary to bend down the lens-bearing parts and a little varia-

Fig. 28

tion does not matter materially, but if there is any space to speak of these ears should be bent with a slight kink near the post (Fig. 29). This can be done with the strap pliers, but care should be used not to take up too much. Under no circumstances bend the

points down, leaving an opening between the lens and the strap (Fig. 30), as this will work loose almost immediately. In some cases where the strap has been opened as much as it will stand in fitting strong concave lenses, or if the workman does not have

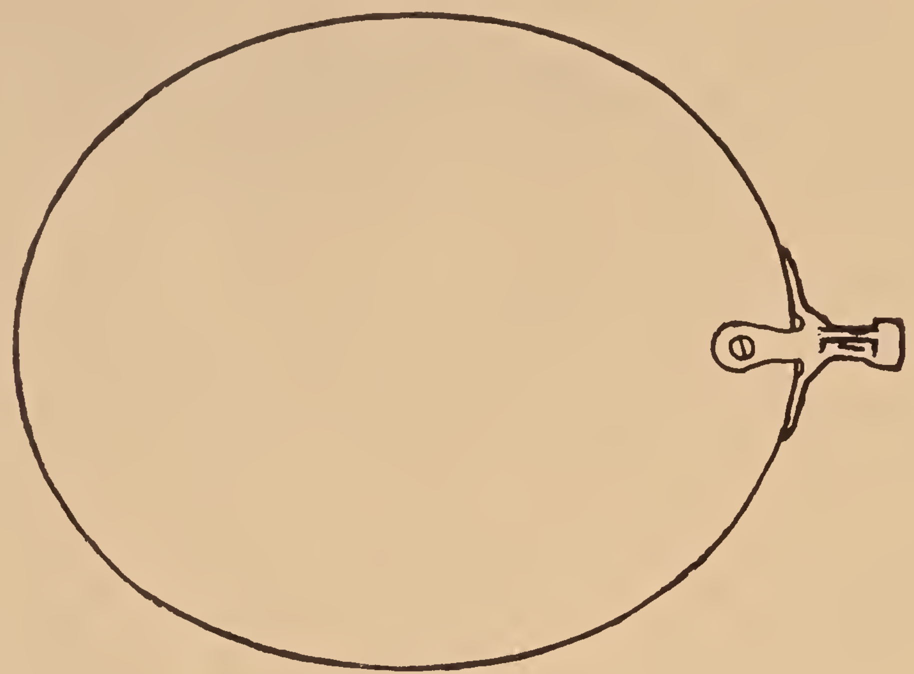

Fig. 29

a pair of strap pliers, it will be necessary to file the edge of the lens to allow it to go into the strap, but this method should not be used unless absolutely necessary. It is, however, desirable to do this on strong concave lenses.

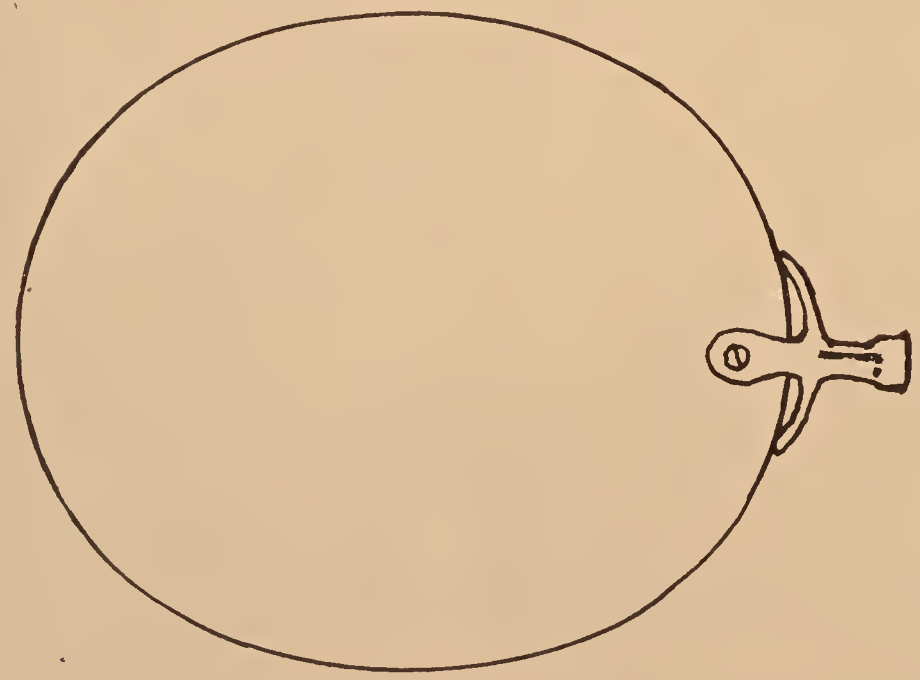

Fig. 30

In fitting torics the strap should be bent with the snipe nose pliers to conform to the curve of the glass (Fig. 31). Although this is really no more difficult, most opticians prefer to send the

mountings to the prescription houses and have these lenses mounted, as the lenses are expensive, and if one is broken it takes away the profit. Occasionally an old pair of lenses is sent in to be fitted with new mountings and the holes are so large that it is impossible to fit a strap so that it will look well. In cases of this kind a plug of tinfoil or of wood can be inserted in the hole nearest the edge of the lens and this will take up the space between the lens and the lens-bearing parts of the strap. There are also strap tighteners on the market for this purpose.

There is also a device on the market supposed to prevent breakage and this is used when fitting expensive lenses, such as fused bifocals. This consists of a rubber tube and a glass screw, with a long pin on the end of the threaded part. After the screw is set up it should be cut off and finished. If a screw finisher is used the end should be left a little long to allow for rounding. If it is cut too short the tool will cut into the strap. If you do not use a screw finisher, cut the screw fairly close and file the end with a flat file almost down to the strap. A piece of card-board, or a brass plate having a square place cut out for the strap, should be used to lay over the glass to prevent the file from

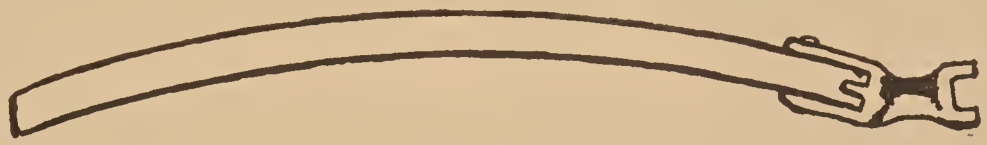

Fig. 31

scratching. There is also a new plier on the market for this work which cuts the screw so close that it does not require filing.

If the optician does his own drilling he can, of course, drill lenses to suit himself. There are, however, a great many who order lenses drilled and do the mounting themselves. Many of these opticians believe that lenses should be drilled so that all that is necessary to do is to screw them into the mounting. If lenses were drilled this way a great many would fit too loose, and a poor job would be the result. The right way is to have them all a little snug and then fit them as before described. To do this a complete set of tools is necessary and care should be used in fitting. If the optician would only realize that men doing the mounting in prescription jobs are the most expert optical work-men and have spent years learning the trade, there would not be very many complaints regarding the drilling.

The mounting of frameless lenses is a trade in itself and too much care cannot be used in selecting the thickness of lenses and straps. The strap plier has simplified the mounting of frameless lenses wonderfully and some opticians have a wrong idea of this tool. It is not only designed to bend a strap from 2 mm. to 4 mm., or *vice versa,* but it should be used in place of the snipe nose plier in fitting almost every lens. In large shops the men mounting rimless work have two pairs, one with a short hook for the regular jobs and one with a long hook for extreme cases.

CHAPTER V

Bifocals

Bifocals have occupied the attention of opticians for the last few years on account of the wonderful improvements. Although the fused bifocals are the latest, it is quite a proposition to make them. Consequently, about the only style that the ordinary optician can make is the cement.

CEMENT BIFOCALS

In making cement bifocals the distance lenses are ground the same as usual, except that when grinding to frame they should be left a little large, or about 1 mm. between the joints. The wafers are about 30 mm. round in the rough, and if the prescription is such that one wafer can be used for two, it should be split in the center, using a hand diamond or a sharpened rat tail file. They can, however, be edged in quantity in the frameless machine before splitting, but care should be used not to screw them in too tightly. It is not practical to attempt to edge less than a pair. If ground in this way they will be left 28 mm. diameter and then cut in the center.

It is always advisable to center wafers when possible, and if the prescription reads, for example, distance + 2, reading + 4, the power of the wafer is equal to the distance. As a spherical lens is practically two prisms with the bases together, by fitting the wafer with a thin edge upward and the thick downward, the prismatic power is neutralized (Fig. 32). When the power of the wafer is stronger than the distance, it is necessary to cut it nearer the center to obtain less prismatic power, consequently two wafers must be used. When the power of the wafers is weaker than the distance lens, it will be cut as far from the center as possible, to obtain all the full prism power.

It is, however, practically impossible to vary this very much, as the wafers are not large enough. The only way that this can be obtained is to grind prism wafers. It is not absolutely necessary to do this as a little variation in the center does not matter

much except that the centers must always be on the same horizontal plane. In other words, do not have one center up and the other down, as one wafer centered and the other not, as this will cause the patient quite a little discomfort perhaps, and when they return, complaining, you will be at a loss to know the cause of the trouble.

When fitting plano wafers to cylinders with the axis at 90°, always cut them from the center (Fig. 33).

After the outside edge is finished (leaving the bottom rough) it is ready to be cemented. Clean the distance lens and the contact surface of the wafer carefully with alcohol. Put a small drop of cement on the lens and place the wafers in position. Hold the lens over an alcohol flame, or if gas is used, a Bunsen burner. Do not use a white flame, as it will smoke the lens. An ordinary wood spring clothes pin is very convenient for holding the lens, or tweezers can be used. Heat the lens gradually until the cement boils, then remove it from the flame and allow it to cool; at the same time place the wafer in position with a stick or tweezers, being careful to press out all bubbles. When it is

Fig. 32

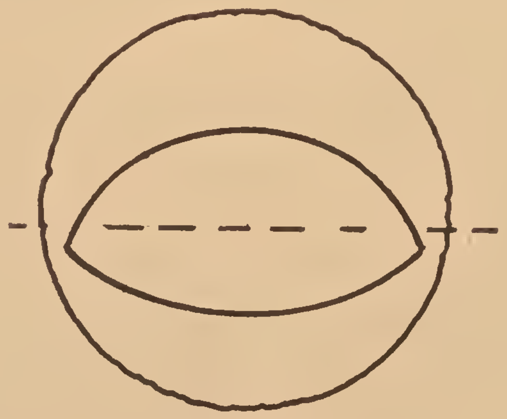

Fig. 33

cool, see that it is firm and cannot be moved. If so, the cement was not cooked enough. If it appears yellow when laid on white paper, it is cooked too much and burned.

There is another method of cementing where the cement is prepared first and in this way it is necessary to cook a quantity of cement in a jar slowly. It requires quite a little experience to get this just the right consistency. The cement should be

cooked so that it is quite thick, applying it to the lens with a stick. With this method it is only necessary to warm the lens and spread the cement evenly over the surface as though it was ordinary

Fig. 34

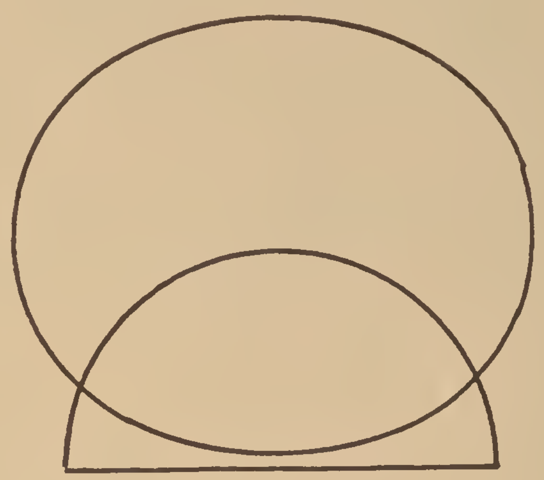

Fig. 35

liquid glue. The wafer is then placed in position and allowed to cool.

Strictly speaking, all wafers should be set in 1 mm. toward the nasal side, although this is not necessary when using large wafers. The smaller styles, such as the horseshoe shape, should be cemented in this way.

CONCAVE BIFOCALS

In making concave bifocals the wafers should be cut so that the thickest part is upward (Fig. 34). This is to neutralize the prismatic effect of the distance lens. After the wafer is properly placed and the lens is cool (Fig. 35), the lower edge can be cut off, using a pattern the shape of the distance lens. It is then beveled, if for frame, and ground down to size; if for frameless, it is ground to conform to the shape of the distance lens and beveled slightly to take off the sharp edge.

The lens should then be cleaned with alcohol, or naphtha if preferred. If it is then found that the cement has started, warm the lens slightly and the spots will probably disappear.

FRAMELESS CEMENT BIFOCALS

In making frameless cement bifocals it is a good plan to drill the lenses before cleaning, as this prevents the drilling fluid

working under the wafer. Wafers should always be fitted to frameless lenses if possible before drilling, as there is less liability of cracking. Opifex bifocals are a form of cement, but the wafer is ground by a patented process so thin that they cannot be edged by hand. They are transferred directly from the block to the surface of the lens and cemented by electric heat. These must be ordered of the prescription houses, although the distance lenses can be ground and sent in to have the wafers fitted. There is little saved in this way, however, so it is just as well to order the lenses complete.

A wafer having the same appearance can be ground from a regular wafer, and this is called the horseshoe shape. It is no more invisible, however, on account of the thickness. If special wafers are ground for this purpose as thin as possible, and from 22 to 25 mm. diameter, it is possible to make a very fair job. The prescription houses usually charge 50 cents extra over the regular cement price for these lenses. The best way to handle these is to stick them to the end of a stick, about the size of a pencil, with sealing wax. They should be edged carefully to 18 mm. diameter. They are then cemented to the distance lenses in the regular way, but so that the top will be 2 mm. below the center of the distance (Fig. 36). After the lenses are cool, the bottom is cut off and ground, as usual. There is an occasional call for round wafers, usually about 10 mm. diameter. These can be ground in the same way, but cemented to the distance about 2 mm. from the lower edge (Fig. 37). Oval wafers are also ground in the same way.

PERFECTION BIFOCALS

Perfection bifocals are made by grading out the lower portion and inserting the reading lens. The distance lens is first ground to size and the lower part cut with a hand diamond and a round pattern. It is then carefully broken out and ground on a small alundum stone. These stones can be obtained to fit any buff head and in any size. The regulation shape is one inch diameter, although occasionally, when a larger lower is desired, 1¼ inch is used. The lower lens is then cut the same shape and ground on the regular stone to fit this curve. Although these can be ground into the frames separately, it is better to stick

them together with white sealing wax. If this method is used, the wax must be left in (and this is no objection). If cleaned out the lens will be too small for the frame.

Grooved Perfection bifocals have been used to some extent and the advantage claimed is that the parts are interchangeable and can be made up from stock very quickly. The line between the distance and reading is quite conspicuous, however, and for this reason they have never had a large sale, especially since the demand for invisible bifocals.

The distance lenses can be ground the same as the regular Perfection, except that the curve is beveled instead of flat. This

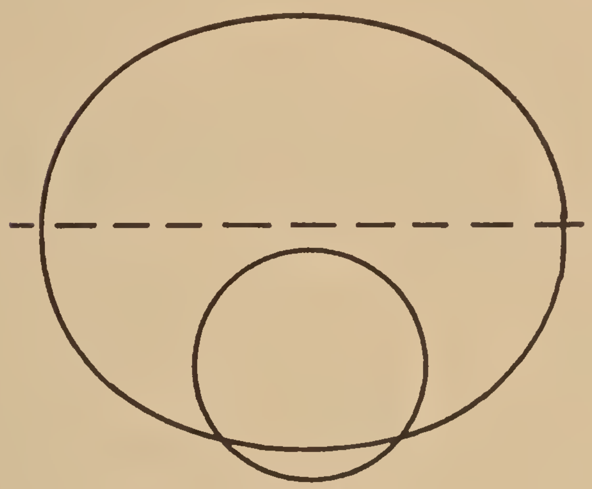

Fig. 36

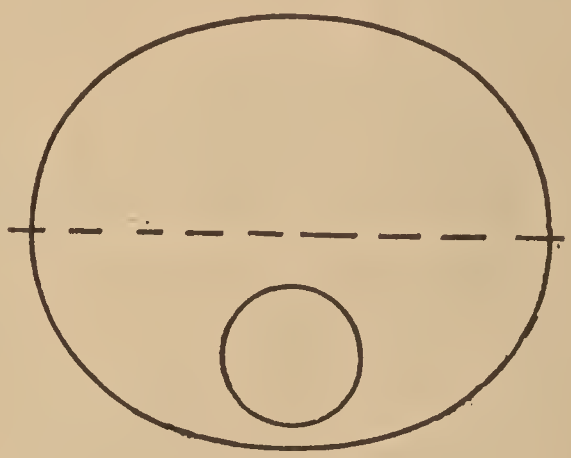

Fig. 37

can be done on the small stone without any difficulty. The lower part is then ground flat to fit the curve of the upper and a groove made with a rat tail file and drilling fluid.

Perfection bifocals are rarely used except in cases where a patient is obliged to work near heat and cannot afford the fused lenses. It is also impractical to make them in frameless.

SPLIT BIFOCALS

Split bifocals can be centered or not as you prefer. Ordinarily they are not, and when ground in this way the four pieces can be cut from two lenses, providing the power is the same in both eyes. The lenses are first split in the center and the straight edges ground on the side of the stone. Composition stones are molded and the sides are usually smooth enough. If not, the right side should be honed the same as the face. If a Craigleith is used the side will have to be turned true with a diamond and

honed with a piece of Craigleith. When the straight edges are ground and beveled slightly to take off the sharp edge, they should be stuck together with white sealing wax. They can then be handled as one lens and cut to size with a pattern. They are also ground the same as any lens. These lenses can also be ground separately if desired, but it is more difficult to hold them when trying in the frame. If centered lenses are required the halves should be cut from the center of the lens and a pattern having this shape will be required.

Whole bifocals are surface ground and are treated the same as an ordinary lens when ground to size. These are not recommended on account of the prismatic effect.

FUSED BIFOCALS

Fused bifocals are a surface-grinding proposition and will be described under that heading later. The blanks can be obtained and if care is used it is not difficult to surface them. At present, however, we will suppose that you prefer to buy them uncut and edge them yourself. When ordering them from the jobbers, full information must be given, such as distance and reading powers, diameter and height of reading portion, axis, frame or frameless, if reading part is to be set in and size of eye. When the lenses are received the axis should be marked and a cutting line drawn. The reading portion is then dotted with ink around the edge so that the circle can be seen easily. The usual diameter is 18 mm., and the height is within 2 mm. of the center. After the axis and position of the disk is inspected the lens is cut by pattern. Although these lenses can be edged by machine, it is recommended that they be ground by hand. The position of the disks can then be watched and there will be less liability of spoiling them. Also be particular that the disk is not scratched as flint is much softer than crown glass. In edging these lenses the disks should be first considered; that is, the shaping of the lens should be done on the lower edge first to make the disks the same height. After these have been made just right, proceed to shape up the other part of the lenses. In making the various combinations it is necessary to use flint of different indices and some of these grind quite hard. For these lenses Craigleith stones will be found more satisfactory.

CHAPTER VI

Bridge Bending and Truing

Bridges can be bent before or after mounting, and, although there is really no preference, some opticians obtain better results one way and some another. When bending an unmounted frameless bridge, or a frame before the lenses are inserted, gripping pliers can be used to hold the strap or eye wire so that the operation is simplified. An experienced person, however, can bend just as well after mounting, but the bridge must be held in the fingers. Under no circumstances should the spectacles be held by the lenses as they will surely be broken.

Bridge bending is not hard to learn, but simply requires practice and a good eye. It is discouraged at the first attempt, and the reason is that the beginner starts to bend some frame to certain dimensions, probably selecting a difficult one, and possibly one that could not be bent successfully anyway. In starting this work, select some old frames of soft metal, such as German silver or Roman alloy, as these make the best frames to practice on, and always have some dimension to work to, as nothing can be accomplished by bending at random.

For the first operation take a frame, say 60 mm. P. D., and bend it to 58. This is done by holding the bridge with a pair of No. 36 pliers in the left hand and gripping the shank of the bridge with a pair of round or snipe-nose pliers about half way from the eye wire to the turn, and, with a slight twist to the right, the eye is bent toward you (Fig. 38). Then grasp the shank near the eye wire and bend the eye back, and you find that the shank has the desired bend and the eye has been thrown in quite a little. The amount, of course, depends on the twist.

After bending this to the required P. D., bend it back again to the original shape. This will give you practice in widening the P. D. This is accomplished by straightening the shank with a pair of snipe-nose pliers; in other words, take out the curve known as the 47 style. In this operation the eye is thrown forward and it should then be brought into line with the No. 36 pliers.

A frameless bridge is bent the same way, except that it is necessary to have different pliers to hold the strap, and for this purpose the No. 39 angling pliers are the best (Fig. 39).

Next try raising and lowering the bridge. This is done by holding the eye-wire with the No. 36 pliers or the snipe-nose in

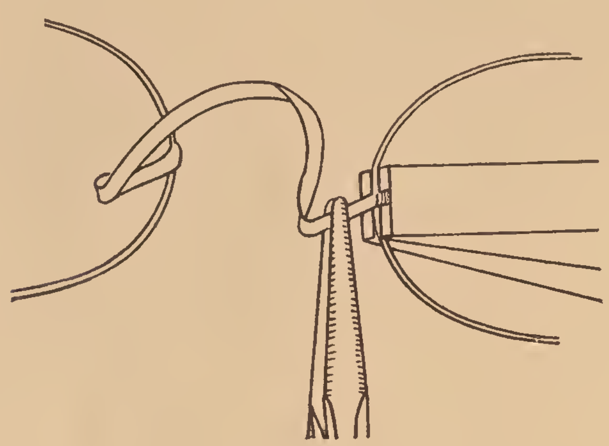

Fig. 38

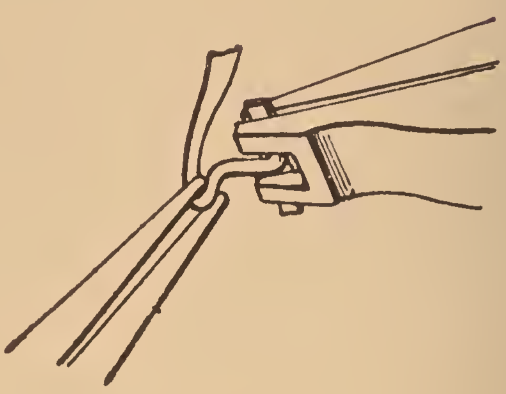

Fig. 39

the right hand and, grasping the crest of the bridge with the thumb and forefinger of the left hand, bending it up or down. This, of course, changes the angle of the crest a little, also the inset or outset, still it is the first step necessary (see Fig. 40).

If you desire to lower the bridge and keep the angle the same, bend the bridge down, as described in Fig. 40, then grasp

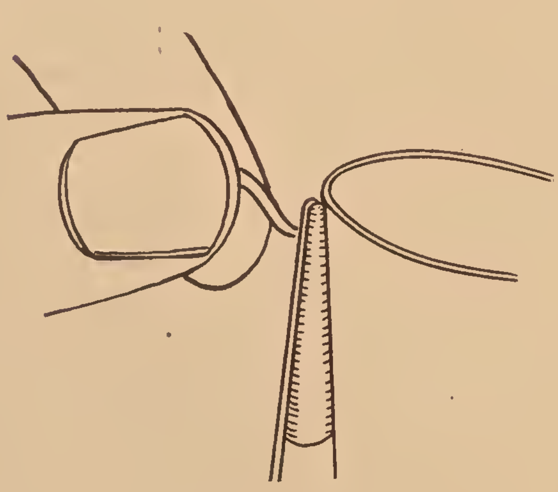

Fig. 40

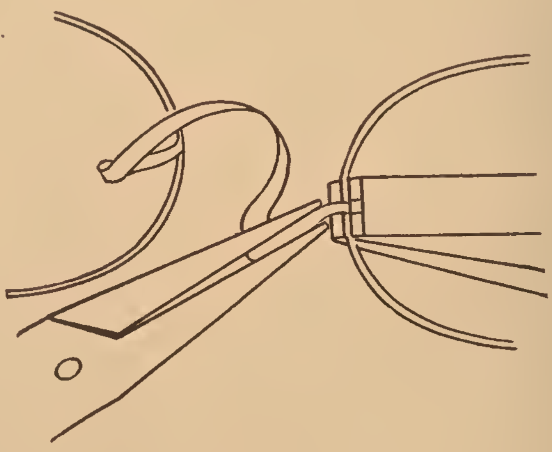

Fig. 41

the frame with the No. 36 pliers (if frameless, the No. 39 pliers) in the right, and the shank of the bridge with a flat-nose pliers in the left hand, bend the shanks downward (see Fig. 41). It is impossible to raise the bridge and keep the angle of the crest and the inset or outset the same, except by shortening the shanks, and this should not be attempted until the first operations are mastered.

To widen the base take a pair of flat, or snipe-nose pliers, and place a piece of cloth between the jaws to prevent marring the bridge, and flatten it to the required measurements and shape; then straighten the frame and you will find that the bridge is right, but the P. D. is wide. The shank can then be bent, as explained before, to shorten the P. D.

To increase the outset it is necessary to shorten the shanks, and it is quite difficult to do this without marring the stock, but if you go slow, bending a little at a time, this can be done all right. The first operation is to grasp the bridge with the thumb and forefinger of the left hand and, with a pair of round pliers in the right hand, gradually open up the turn, beginning with the

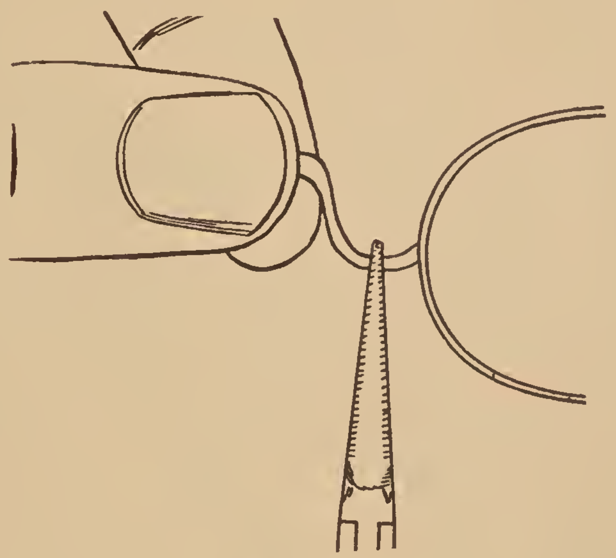

Fig. 42

small end of the pliers and gradually sliding the bridge toward the larger part of the pliers (see Fig. 42). After this has been spread sufficiently, grasp the shank a little way from the turn and bend the eye straight, at the same time pulling forward on the bridge with the left hand. This pulls a little of the stock in the shank into the arch. It can then be trued up and the operation repeated on the left side.

To decrease the outset or increase the inset the shank must be lengthened and the first operation is to open the turn of the shank a little, as before, but, instead of grasping the shank back from the turn, grasp it near the turn, or, if possible, in the turn, bend the eye straight and true up. Repeat the operation on the left side.

After practicing with the sample frame select a good frame

to bend to measurements. The principal part of selecting frames for prescription jobs is in using good judgment, and you should train yourself to judge whether a frame can be bent to the dimensions required or not. If you do not learn this you can never learn to bend and will spoil stock, also waste time. In

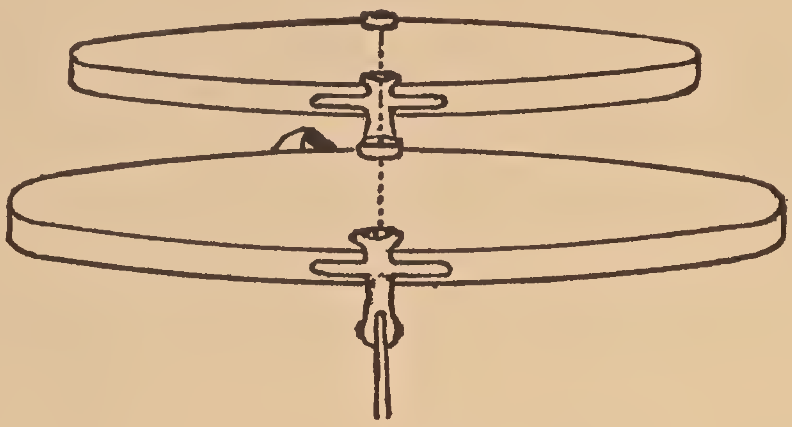

Fig. 43

selecting a frame try and get everything right but one dimension, if possible, and it is best to change the P. D., as this is easier than anything else. Do not take up a frame at random and expect to bend it to fit the required dimensions, but study it carefully and learn to judge it before touching it with the pliers.

After the lenses are mounted they must be trued up, and, if the bridge has been bent previously, it is a very simple operation. If it has not been bent it is best to straighten it somewhat and lay it on the pupilometer to get an idea of what is to be done. The first operation is to get the lenses in the same plane, so that they will lay flat. Then turn the spectacles over, holding them endwise and sight across the outside surfaces. The four glass screws should then be brought into line (Fig. 43). The spectacles should then be measured for all dimensions and any necessary alterations made at this point.

We now suppose that the front is correct and true, and the attention turned to the temples. First straighten and true them so that the curve will be uniform. Then hold the front endwise with the temples upward, and in almost every case they will be found with one angled one way and the other in the opposite direction (Fig. 44). A pair of parallel jaw pliers (No. 40) should then be used to grip the endpiece close to the strap or eye-wire, and, with a pair of snipe-nose pliers, the joint is angled to make the temple perpendicular (Fig. 45). The temple is

then shut down, and, if it is not in line with the endpieces, it is turned to the right or left, both pliers being used in the same position. This operation is then repeated on the other joint. If the front is to be angular, the joints are tilted in the same manner.

Should it be necessary to set the temples back, the tip can be filed at the joint if gold or steel, but in gold filled it is better to hold the joint with a pair of pliers and pull the temple outward with the fingers. Although one may be broken occasionally, it saves filing the gold, which is very important when handling filled goods. There are no pliers on the market for holding the endpiece in this operation, but they can be made specially for any make or style of joint.

In truing eyeglasses there is very little to be done except to straighten the lenses so that they are in the same plane, and adjust them so that the droop will be right. This is a very important feature and many opticians do not understand that an eyeglass should be placed as far back on the nose as possible. A great many times a patient requests that the spring be tightened, when in reality it should be opened more to allow the guards to

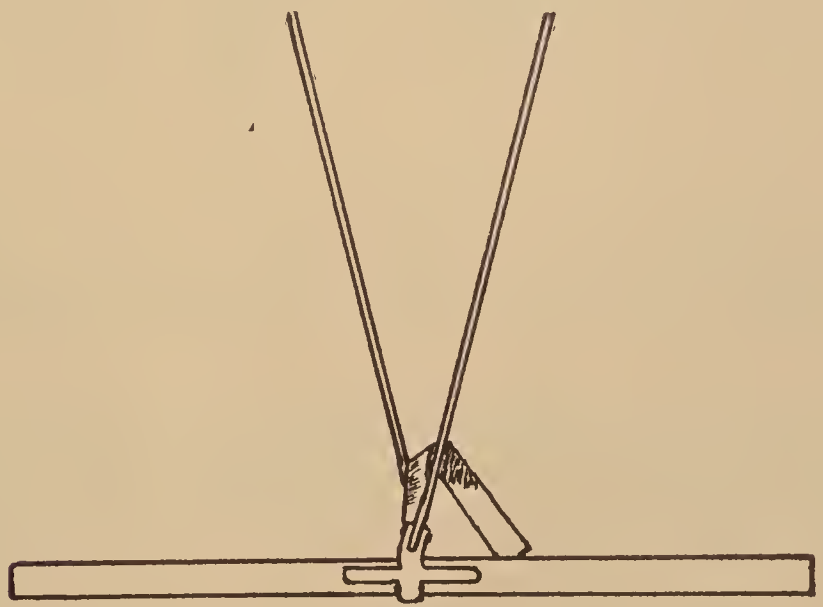

Fig. 44

go back farther. Each time the spring is tightened the glasses are thrown farther forward and, finally, they will grip only on the very edge. Now, in truing, the lenses are allowed to droop a little so that when placed on the nose they will be horizontal. If they were in this position before placed on the face, or if the guards are not spread enough, the lenses will set upward. This

not only looks badly but the lenses will be too high. A great many times eyeglasses are sent to the prescription houses for drop studs or guards to set the lenses lower, or even for new lenses drilled above center, when all that is necessary to make the glasses right is to droop the lenses a little more.

When lenses are drilled above center they must always be turned down. For this operation grasp the stud with a pair of stud pliers in the right hand and hold the spring with the left. By bending the spring away from the lenses it will give them the required droop. Then take hold of the studs with both hands

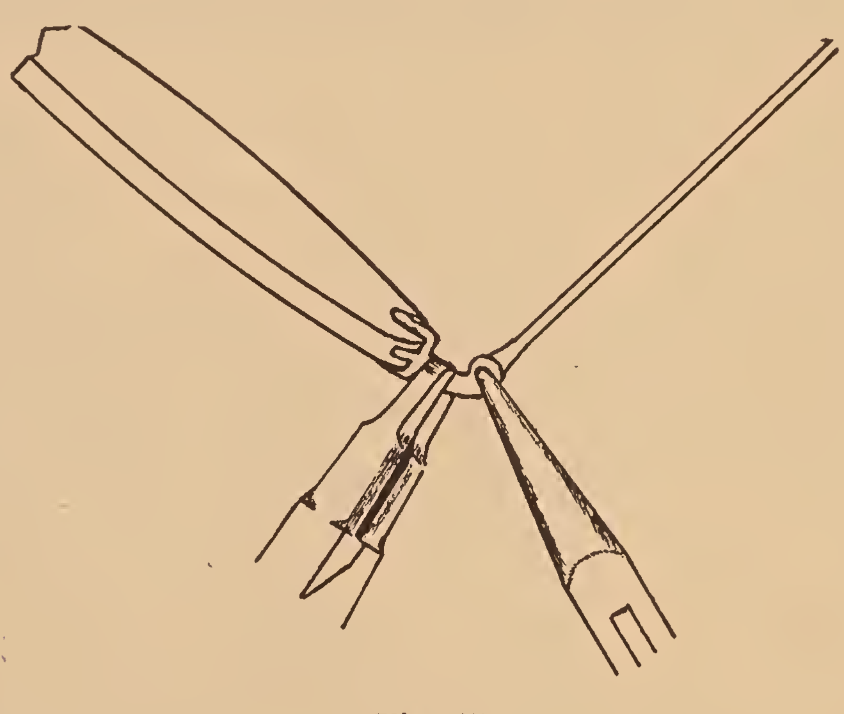

Fig. 45

and open the spring a little until the lenses appear to be in about the right position. The guards should then be adjusted so they are parallel.

For truing a fingerpiece mounting use the No. 40 pliers, placing the jaw marked "top" with the large hole over the head of the screw on which the spring is coiled. The lenses can then be changed to any position without damaging the mounting (Fig. 46).

When it becomes necessary to drop the lenses in an eyeglass frame to make them lower on the face, the screws should be loosened in the end-pieces and the lenses twisted so that they set upward considerably. Then grasp the studs with the stud pliers in the same manner as before described for frameless, and twist the eye downward, etc. If the lenses need to be raised, they

should be twisted downward in the frames, the studs grasped with the stud pliers, and the spring bent backward toward the lenses, thereby raising the eye to the required position. This is another case that occurs frequently in prescription work where

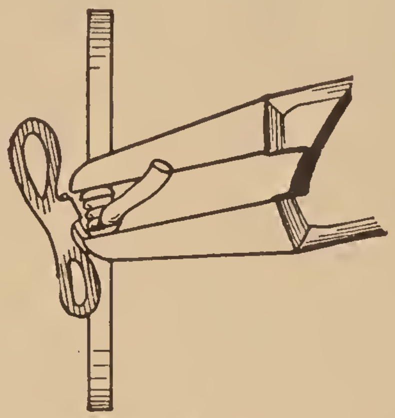

Fig. 46

frames are ordered with studs above center. If the lenses are fitted, they can be adjusted easily and no explanation is required; but if the frames only are ordered, it is almost impossible to shape them so that they look right, and, even if this is possible, the optician can easily change the position in fitting them up.

Toric lenses can be adjusted so that they curve slightly to conform to the features. If there is too much curve, however, it may be objectionable to the patient. It is well to remember this point, as frequently people complain that they are unable

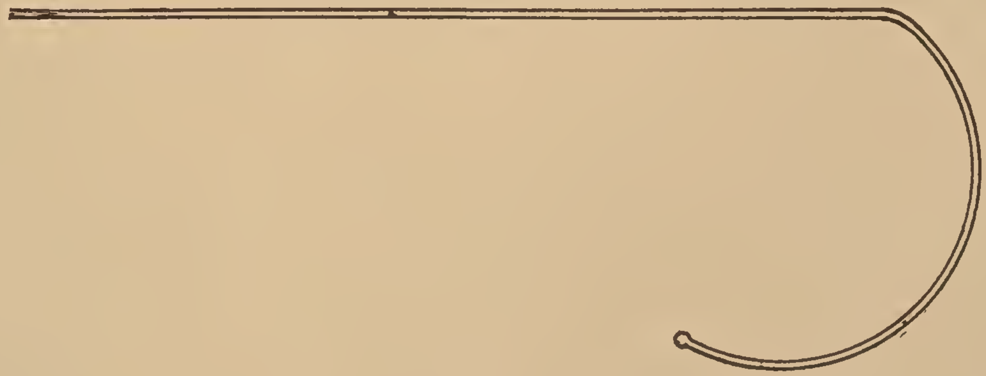

Fig. 47

to wear torics, and, if the glasses are adjusted so that the angle is changed, it makes them entirely satisfactory.

This also applies to the angle for reading, but not so much with torics as flat lenses. According to theory all glasses should be angled slightly, and the amount depends somewhat on the features.

Lenses should never be drilled below center. If the spectacles are too low on the face, the bridge can be altered to raise them even if it is necessary to make one to order. It is seldom that a regular bridge cannot be used by dropping the shanks.

If eyeglasses are too low they should be raised by changing the guards to some other style. In many cases a regular offset guard with a short blade will accomplish this result. It should be remembered that to raise the lenses the guard should be lower, and to lower the lenses the guards should be higher.

There are so many guards on the market that it is well to look the common styles over, and it will be noticed that the arms are set very differently on different styles. If one is familiar with these styles it is a very easy matter to select a different one to accomplish whatever result is required. When there is difficulty in fitting glasses so that they will be low enough, the drop eye lenses sometimes are a great help, especially when the eyes are deep set.

In truing temples do not leave too much curve to them, but have them so that they will be straight to the turn so that all the curve will be behind the ear. The right way to fit a temple is to make quite a sharp turn at ear (Fig. 47). These not only prove more comfortable but they look better. When the nose is sensitive, cylinder bridges, cork or shell nose guards can be used, but when fitting the latter the bridge must be somewhat higher to allow for the thickness of the cork or shell.

CHAPTER VII

Surface Grinding

Surface grinding is, in reality, a separate branch of mechanical optics, for the reason that few opticians doing their own work attempt to do this work. Usually an optician puts in a plant to do his own edging, and for this part of the work he has time enough, but it is not practical to attempt to surface the few odd combinations that he may be called upon to supply and attend to his trade at the same time. The right way is to install the outfit for edging, and, as his work increases, he can afford to hire a man for this part of the business. He can then install the surface plant for the accommodation of his customers or for the advertising feature.

It requires very little time to grind an ordinary lens if the workman is efficient, and it often saves a delay of twenty-four to thirty-six hours if it is necessary to send out of town to a jobber.

A surface machine can be obtained for $58.50 and upward. The simple machines have one speed, and although this is sufficient, it is often convenient to have two speeds (Fig. 48). If one speed only is used, 900 to 1200 revolutions per minute are most satisfactory. If two speeds are used, 600 and 1200 are the most common.

A lens can be ground using almost any speed, but, of course, the higher the speed the faster the grinding, although it requires more attention as it is also necessary to feed the emery faster. There is a limit as to speed, however; if it runs too fast it throws the emery off quickly and you then are grinding on the tool, and in this way nothing is accomplished. It must be remembered that it is the emery that grinds and not the tool.

The electrical-driven machine is very convenient as the motor is enclosed in the base, and, consequently, does not require countershafts or belts (Fig. 49). It also not only requires very little power to operate it, but when the machine is stopped it is using no current. These machines can be obtained in direct current only at present. There are also automatic surface machines on the market, and these can be used either by hand or

not as you choose (Fig. 50). Automatic work is somewhat slower, and most opticians having these machines use this attachment for polishing only.

The tools cost about two dollars per pair and the gages about

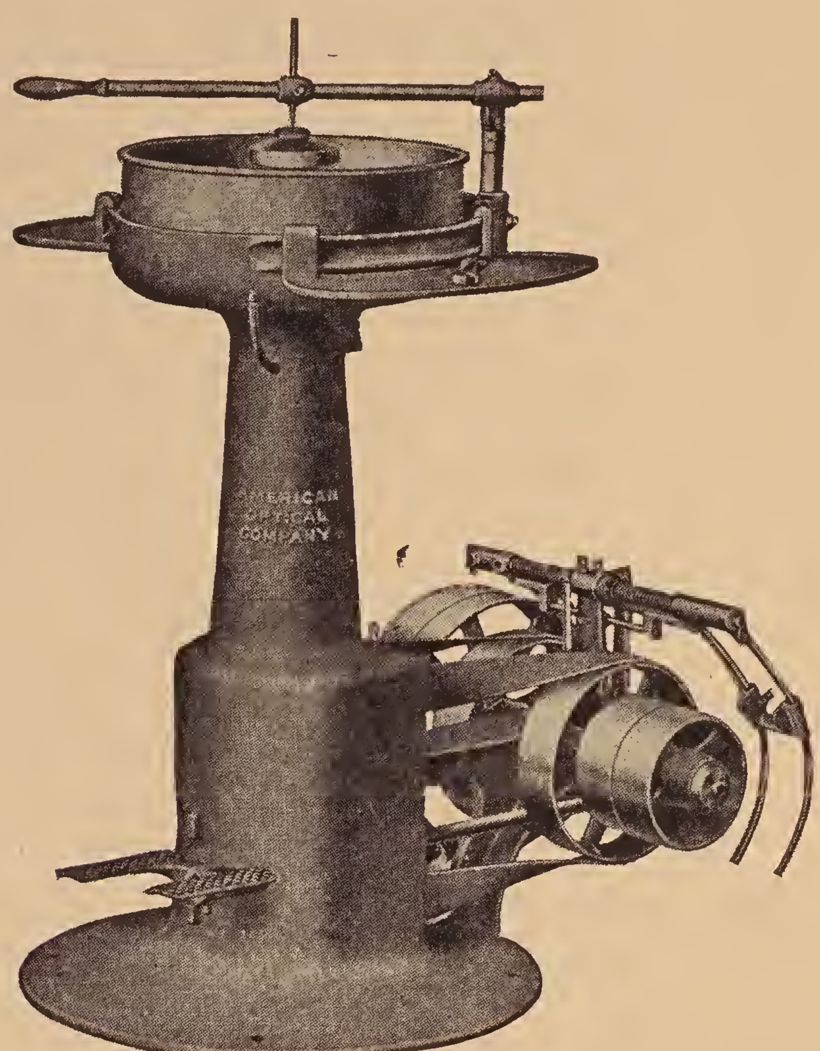

Fig. 48

seventy-five cents per pair. These are not supplied with the machine, so it is necessary to order whatever powers will be needed. It is well to have each .12 to 3 D., then .25 to 8 D., then .50 to 14 D., and each diopter to 20 D.; also a plano and an extra 6 D. for roughing torics. It is also necessary to have a pair of gages for each power.

Another point that must be considered is whether B. & L. or A. O. Co. glass will be used. If both, it will be necessary to have a set of tools for each, although by making an allowance it is possible to work very closely on one set of tools. There is about .03 D. difference on each diopter, and, as this is so small, it will come near enough up to 2 D., but above that select the nearest tool and polish it stronger or weaker as the case requires. (This will be explained later.)

The index of A. O. Co. glass is 1.507 and B. & L. 1.522. To obtain the required radius multiply the focus wanted in inches by the index of refraction, — 1. For example, 1 D. is 39.37 inches and the index of B. & L. glass is 1.522. We would then multiply 39.37 by .522, which would make the radius of the tool for 1 D. 20.55 inches. This does not enter into the work in any way, however, unless the optician is mechanically inclined and he desires to make his own tools. It is simply necessary, when ordering tools, to state what glass they are to be used for.

For grinding material the following grades of emery will be required: No. 60 for roughing, No. 100 for smoothing, No. 4-F for finishing and a grade of washed emery for fine finishing. The first three mentioned should be bought in ten-pound cans; the washed can only be obtained from optical concerns in five-

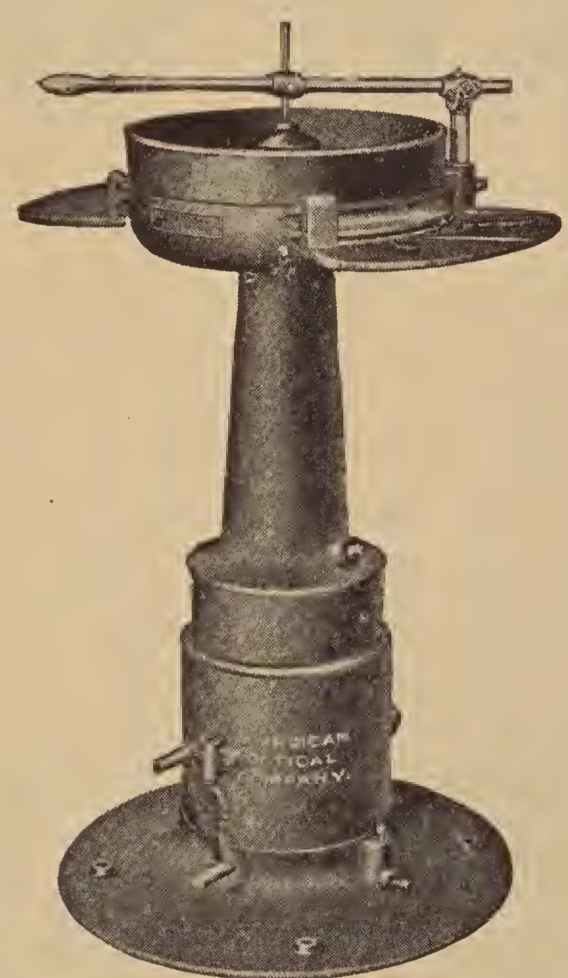

Fig. 49

pound cans. This is also very expensive, as compared with other grades, but it lasts a long time as it is necessary to use only a very small quantity at a time. It should also be remembered that a good finish saves a great deal of time in polishing.

There are several kinds of grinding material on the market,

such as carborundum, corundum, alundum and crushed steel, and these are graded about the same as emery. They cost more, but are supposed to cut faster and stay sharp longer, but for a single machine it hardly pays to mix the different materials. It should

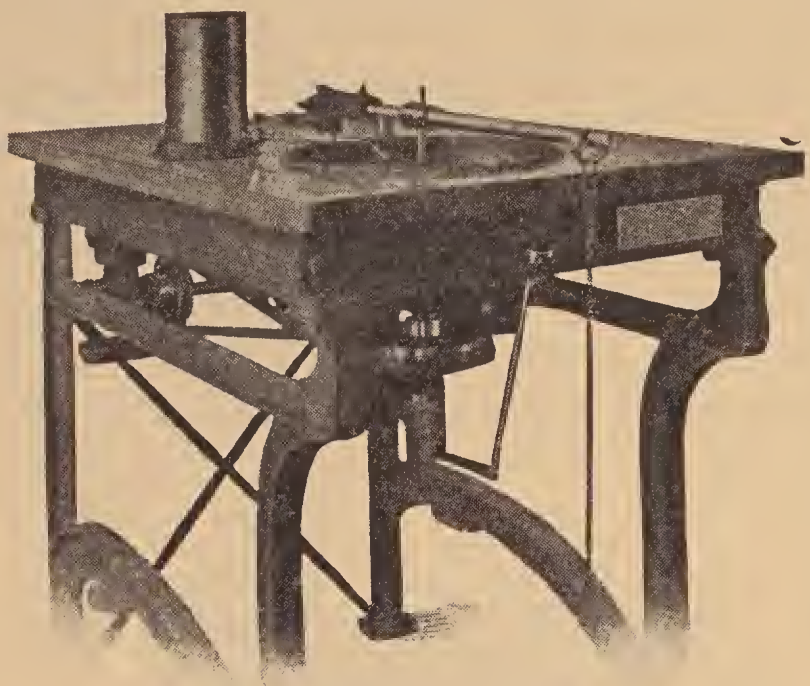

Fig. 50

be remembered that the sharper or rougher the materials used the harder it is on the tools and they must be watched more carefully to see that they are kept true. For polishing, rouge is used, and this comes in several grades. The grade used by jobbers is all right and should be ordered in five-pound boxes. There is also a black pigment used by some opticians. For polishing, cloth, felt or broadcloth is most commonly used, and, although this can be obtained almost everywhere, it is more satisfactory to order it from the jobber and you will then be sure of getting a quality that will do satisfactory work. Pitch can be obtained in one-pound cans from the jobbers, and this is used to stick the lenses on to the blocks. It can be made easily by taking a quantity of resin and melting it. When it is poured off to cool, a little turpentine should be added to soften it, or, in other words, to keep it from getting brittle. In the winter it should be softer than in the summer, as the temperature will affect it. If it is too soft the glass will slide on the block in polishing, and if too hard it will jump off the block when chilled in water. To make it black a little lampblack can be added. The dark surface makes it much easier to inspect the lenses when polishing.

A few blocks are usually furnished with a machine, but more will be required. Those furnished are round and flat (Fig. 51), and these will do for weak power lenses. For stronger powers deeper holes are needed, so they are made with a lug on the back (Fig. 52). Some of these should have a convex face (Fig. 53) and some concave for torics (Fig. 54). If square blocks are used it will be much easier to caliper the lens while grinding. A few small, round blocks will also be needed for wafers (Fig. 55).

Before fitting the tool to the machine it should be tried with the gage, and if it is not perfectly true it should be made so before attempting to grind the lens, otherwise the power will not be correct. A great many opticians use tools without gages, or, even if they do have them, they allow the tools to get all out of true and then send them to a machinist to be put in shape. This is entirely wrong and unnecessary, as it is a very easy matter to true the tool a little each time. The method is the same as trying the surface of a board to see if it is square; that is, the tool is held in one hand on a level with the eye and the gage is held perpendicular to the surface. If no light can be seen it will fit perfectly; if light is seen, notice whether it is weaker or stronger or if there is simply a high or low spot. In grinding, usually the tool wears on the side and the center will be high. For this work a piece of carborundum 8 in. long, 2 in. wide and 1 in. thick is used of a fairly coarse grade. The tool is placed on the spindle and run at full speed. With the carborundum stick it can be turned nearly as well as in a lathe. A little should be taken off at a time, however, and tried frequently with the gage.

There are usually two pans furnished with the machine; one of these should be used for grinding and the other for polishing. Some rough emery (No. 60) is placed in the pan with quite a lot of water, enough so that it covers the emery. It will do no harm if there is too much as the emery will stay at the bottom. In roughing, this is fed on to the tool with a spoon or with the fingers. The No. 100 emery should be placed in an agate drinking cup, or something of that nature, and wet so that it will be in the form of a paste. The No. 4-F emery can also be placed in a cup of this kind, but the washer should be kept in a small jar or box with a cover. The rouge can be placed

in a cup and wet in the same way. An extra cup of water should be kept at side of this, and, in polishing, this is applied with a brush. It will be necessary to have a large pail of water handy for rinsing the lens from time to time, and, after these different receptacles are arranged conveniently, you will be ready to grind.

For surface grinding it is necessary to have a stock of

Fig. 51

rough cylinders. These come in thickness varying from 2 to 10 mm. Those most commonly used are 2½ and 4 mm. In selecting the stock for any particular job it is well to caliper them, as this not only saves glass, but also saves a great deal of time in roughing. For this work a pair of calipers graduated in 1/5 mm. is

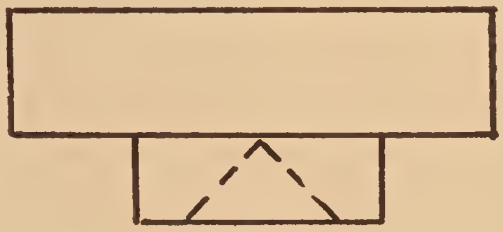

Fig. 52

used (Fig. 56). It is necessary to allow 2/5 mm. for each diopter and 4/5 mm. for each prism diopter. To this is added about 2/5 mm. for grinding. For example, if we are to grind $+ 1 = + .50$, a $+ .50$ cylinder is selected 4/5 mm. thicker on the edge than the required thickness of the finished lens, thus

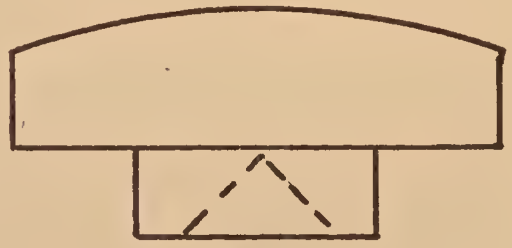

Fig. 53

allowing 2/5 mm. for the curve and 2/5 mm. for the grinding. When grinding a convex lens the center is hardly touched, providing the stock is about the right thickness at the start, but, unless the lens is fined down very carefully, which takes extra time, you cannot help grinding off a little extra glass, and, for this reason, a little allowance for grinding must be made. If

the combination to be ground were — 1 = — .50, a rough cylinder having about the right thickness on the edge would be selected as practically the center only is ground. The allowance for grinding is all that would be taken off the edge. If the combination to be ground were + 1 = + .50 axis 90 = 1° in, it would be necessary to allow 4/5 mm. more for the prisms. For example, the lens when finished should be 2 mm. thickness on the edge; to this is added 2/5 mm. for the one diopter and 4/5 mm. for the prism. To this is added 2/5 for grinding and the rough cylinder to be selected would be 3 3/5 mm. For this it would probably be necessary to use 4 mm. stock. It should be remem-

Fig. 54

bered that over 4 mm. rough cylinders cost extra for each millimeter thickness.

Toric rough cylinders should be purchased in molded form, when possible, as this saves a great deal of roughing. Most all blanks are made this way at the present time, but some of the smaller manufacturers put them out in flat form. There is also

Fig. 55

another point to be considered in using these lenses, and that is that often it is not possible to get the thickness out. In other words, when they are not molded, so much stock has to be ground out inside that it leaves the lens a knife edge. These can be obtained in plus and minus 6 D. base curve, also plus and minus 9 D. base curve. The majority of combinations can be ground on + 6 D. base, but, as the spherical power increases, it reduces the toric effect so that it becomes necessary to transpose the combination, so that it is ground on a — 6 D. base. It is preferable, however, to grind these combinations on a 9 D. base. For example, + 3 = + 1, if ground on a + 6 D. base, would have but — 3 inside curve. If ground on a + 9 D. base curve it would be — 6 D. on the inside. It could be transposed, however, and

ground on a — 6 D. base curve and it would be — 6 D. on the inside and + 10 D. on the outside. It should be remembered that the base curve is always the weakest meridian on the cylinder side; that is, a + 6 D. base curve is + 6 in one meridian and stronger in the other. The difference will be the power of the cylinder. A — 6 D. base is — 6 D. in one meridian and stronger in the other. The spherical power is obtained by grinding the opposite side.

Another point to keep in mind is that concave toric cylinders cost more than convex, and, whenever possible, all combinations should be transposed so that a plus cylinder can be used. For

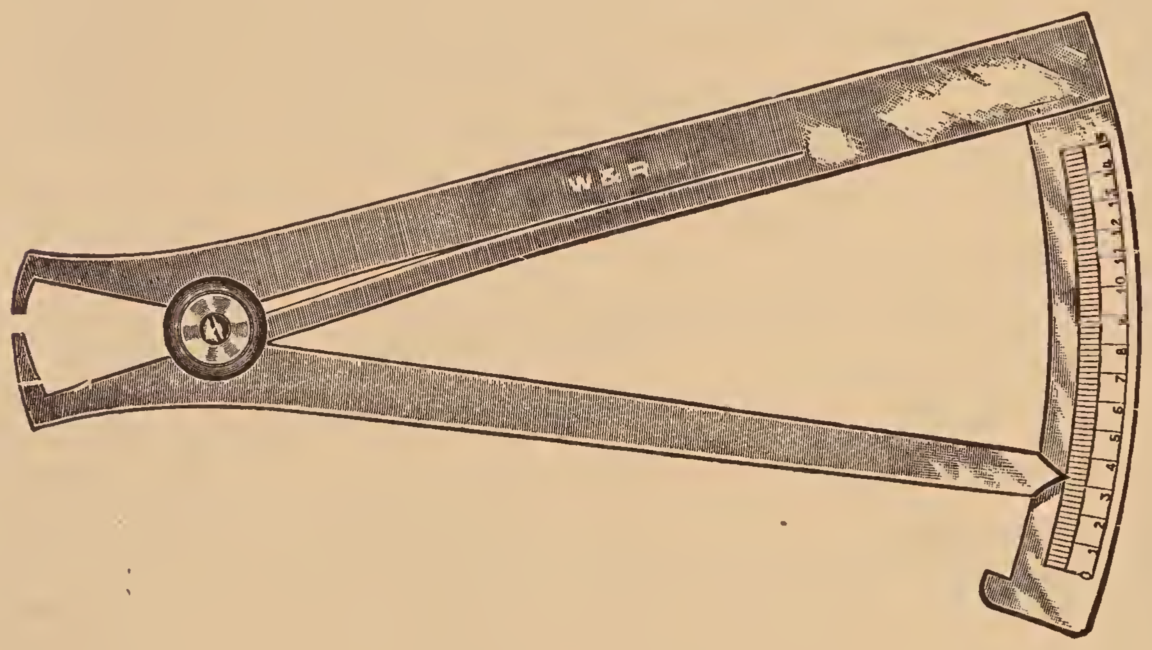

Fig. 56

example, in the combination — 1 = — .50, if it is ground as written a — .50 toric cylinder would be selected and the cylinder surface would, of course, be on the inside. On the outside would then be ground + 5, thus making the — 1 sphere. If this were transposed to — 1.50 = + 50, a + .50 toric cylinder would be selected and — 7.50 ground on the inside to produce the — 1.50 sphere. The reason that concave toric cylinders cost more is that the large factories have not as yet perfected machines for grinding these in quantity the same as the convex, and, consequently, they are ground singly at a greater expense.

When selecting colored lenses it is necessary to have in mind that as the glass is ground thinner the shade will be much lighter, and it is a very difficult matter to judge just how they are coming out. For this reason colored lenses with power are al-

ways expensive as a great many times it is necessary to grind two or three pairs before the exact shade is produced. The demand for colored lenses, however, is so unimportant that they call for little consideration as compared with the colorless variety.

For wafers, spherical lenses are used, but always selected so that one surface is correct. For this Pcx. lens always work in nicely as the old curves can always be found. For example, for the combination — 1 = + 3.50, a + 2.25 Pcx. would be selected, and this would be on the outside + 3.50 and on the inside — 1.25. We would then block it with the convex surface down and regrind the inner to — 1, at the same time reducing the thickness to whatever is desired.

Spherical prisms can be ground on rough prisms or a stronger plano prism can be used to get the thickness required.

CHAPTER VIII

Surface Grinding—Continued

The machine now being in operation, and the emery arranged conveniently, the first operation will be to mark the lens. If a brown pitch is used in blocking, black ink will show well enough, but if black pitch is used, white ink is much better. If a simple compound is to be ground, no marks are required, but with all prism combinations the axis must be marked. This method is the same as for cutting, except that it must be taken into consideration that when the lens is on the block, you, perhaps, are looking at it from the wrong side. This, of course, depends on the combination. For example, if the combination to be ground is — 50 axis 45 = 1° in, the lens can be marked with the cylinder in (or up, as it is laid on the protractor) just as it is to be fitted to the spectacle.

It is, of course, necessary to mark all lenses on the cylinder side, otherwise the marks will be ground off. When this is stuck on the block the cylinder will be down, and you are really working on it as though the axis was 135°. On the other hand, if the combination is + 50 axis 45 = 1° in, it would be necessary to mark it as if it were to be 135°. The reason for this is that you are marking it on the cylinder side, and after this is completed, it is to be fitted to the spectacle with this side out. The reason for marking is to have a line to grind the prism on, in other words, to tell the direction of the base. If this is to be in, the axis must be set at the proper angle so that the prism line must be horizontal. It does not matter, however, how this is placed on the block as long as the relative position of the axis to the base is correct.

If a double prism is to be ground, that is, a lens with the prism out and up, etc., it will be necessary to have a line for both prisms. In marking, the axis is first dotted and laid on the protractor at the proper angle, the prism lines are then drawn and the bases marked with the letter "B". As the prism lines are the only ones that are considered, the axis dots can then be rubbed

out if preferred to save confusion. There is a chart published for calculating the effect of double prisms that is very convenient, but it is not absolutely necessary to use this in surface grinding. A double prism is really a single prism ground at a different angle. For example, a 2° up = 2° out in the right eye would be practically a 3° axis 135°.

For blocking, an ordinary cheap gas stove is sufficient, but a piece of sheet iron should be laid over the top to prevent any pitch running down into the stove and clogging the holes. The blocks should be heated on the stove, and, when good and hot, should be taken off and placed on the bench. A little pitch should then be put on and allowed to melt. The glass to be blocked should be warmed slightly and laid on the block a second and then removed. It will be noticed that some of the pitch sticks to the surface. A little more of the pitch should then be put on the block and the lens laid on a second time, and then removed. In this way you gradually build up a backing for the lens. This operation should be repeated several times until there is pitch enough between the block and the lens so that it will hold securely, and also that there is no danger of the glass touching the iron. This not only prevents scratching, but if there is not pitch enough to form a good bed for the glass, it will crack when pressure is applied in grinding.

Flat lenses do not require as much pitch as those having a concave surface or a toric. Ordinary concave lenses can be blocked on flat blocks, but care must be used to fill up the space with pitch for the reason just stated. For convex toric cylinders, a block having a concave surface should be used, and although the curve should be about the same, it is not absolutely necessary, as the surface can be built up with pitch. For concave toric cylinders, convex blocks should, of course, be used. After the lenses are blocked, they should be allowed to cool gradually. After they are cool, the pitch on the back of the lens that overhangs the block should be scraped off with a knife so that the four sides can be measured with the calipers. Lenses can also be blocked over an ordinary Bunsen burner, and if it is done in this way, the pitch should be moulded into sticks and melted on the block the same as sealing wax is used.

We will suppose that the combination to be ground is + 1

= + 50 cyl. and 1 1/2 strap on the edge when finished. We have selected a + 50 cylinder, 2 1/2 mm. thickness, and have blocked it as described. We then select the tool to grind + 1 sph. This, of course, will be a concave tool to grind a convex

Fig. 57

surface. It should be tried with the gage to see if it is correct. The rough emery is already in the pan, with plenty of water. The block or lens is then taken in the left hand and held on the tool, spooning the emery on with the right hand (Fig. 57). After the sharp edges are ground off, the block can then be placed under the spindle in the handle (Fig. 5). It will then be necessary to adjust this so the lens is in the center of the tool. As to position, the grinder can stand wherever it is most natural. Some of the older machines are arranged so that the handle points

directly to the operator, and some use it in this position; others stand a little to one side. In either case this is somewhat awkward and the best way is to have the handle run from right to left, so that it is in a horizontal position to the grinder (Fig. 58).

The newest machines are made so that they can be adjusted to any position. When the handle has been adjusted correctly, the machine can be started. The lens will then revolve or spin on the spindle, and the grinder then moves the handle forward and back so that the lens will travel from the center to the edge of the tool. This motion is to break up the rings which would form on the surface of the glass if it were held in one position. One must be careful, however, not to run over the center of the tool, or the block may fly off. As the lens is moved back and forth, the emery should be fed continually with the spoon. After the lens has ground a minute or two, it should be removed, and if it is ground all over the surface, it is ready to measure. Now take the calipers and measure all four edges. If it is the same all around, the lens is centered and not prismatic. If there is a difference, take the block in the hand the same as when starting (Fig. 57), and grind off a little of the thick edge, then measure again. If found correct, it can then be placed on the spindle again and ground as before.

The system of measuring should be remembered, that is, 2/5 mm. allowance for every diopter. As we started with a lens 2½ mm. thick and wish to obtain a lens 1½ mm. it will be necessary to grind off 1 mm. or 5/5 on the calipers. In the roughing about 2/5 mm. will be taken off, being careful, of course, to keep it centered as described. Do not be afraid to measure it too much, for it is better to take off a little at a time than to spoil the lens. After it has been roughed down, wipe off the tool and rinse the lens in water. (For this purpose, keep a pail at the side of the machine.) Now take the No. 100 emery, which is in the cup, and grind as before, smoothing the surface and taking off about 1/5 mm. Then wipe off the tool again, rinse the lens and take the No. 4-F emery. This you can apply with the fingers, or a brush if preferred. After this grade, clean the lens and tool again thoroughly and you are ready for the fine finishing. For this operation it is necessary to use but very little of the finest

emery, applying it with one finger. The idea now is to get just as fine a surface as possible to obtain next to a polish.

Although it is unnecessary to waste the emery, all scratches and pits must be removed, as time is not only wasted in trying to polish them out, but the lens produced is not so good. It

Fig. 58

should also be remembered that this grade of emery is expensive. All through these different operations keep in mind that the lens must be calipered frequently to keep it from being prismatic, and also, that as you are continually grinding off glass, you are nearing the thickness required for the finished lens. Also be particular to clean the tool and the lens between each grade of emery used, as one grain of rough emery on the tool when fine finishing will scratch the surface.

If the combination was — 1 = — 50, the operation would

have been the same, using, of course, the opposite tool, but if the order called for a certain thickness in the center, the lens would be 2/5 mm. thicker on the edge. Although this has to be taken into consideration in convex combinations, allowing the lens to be 2/5 mm. thinner on the edge than on the center, it does not make quite so much difference, for the reason that the concave lens is apt to be ground through the center. This will be noted in grinding the stronger combinations, and one must be accurate in measuring when selecting rough cylinders.

For each prism diopter 4/5 mm. must be allowed, so if the combination to be ground was $+ 1 = + 50$ axis $90° = 1°$ in, we would allow 2/5 mm. for the sph. and 4/5 mm. for the prism, making 1 1/5 mm. besides the allowance for grinding. We have already described the method of marking for a prism, and the blocking is the same as for a compound. In starting to grind, the lens is held in the hand (Fig. 57), not on the spindle, as before, but we grind off the edge where the apex is to be, leaving the edge for the base as thick as possible. It will now be seen why it was necessary to mark a mechanical axis or prism line. It should be measured on this line, and the base should be 4/5 mm. thicker than the apex. The two opposite sides are of no account, except that they should be exactly the same thickness. If one was thicker than the other, there would then be a prism power up or down as well. By this it will be seen how to grind a double prism. For example, if the combination was to be $+ 1 = + 50$, axis $90° = 1°$ in and $1°$ up, we would have 4/5 mm. difference on the edge between the apex and base on the 180° line, and also 4/5 mm. difference on the 90° line. When the lens has been roughed down in the hand so that the prism power is approximately correct, it can be placed on the spindle (Fig. 58) and roughed down to the proper thickness. It should be remembered that all the prism power must be roughed on with the block in the hand, and that the lens cannot be ground prismatic on the spindle. This does not mean that the lens will not grind prismatic because it will grind off center more or less, but it means that you cannot control the direction of the prism power on the spindle. As different grades of emery are used, the edge must be measured constantly, and if there is any variation

found, take the lens in the hand again and true it up with whatever grade of emery you may be using.

In grinding a cylinder prism, the plane tool is used, and the prism power only has to be considered. For example, a + 50 axis 45 = 1 in would be marked and blocked as usual, and the apex ground to the proper thickness, say 2 mm. The base should then be 2 4/5 mm. thickness. The plane tool should be kept as accurate as possible for the reason that the slightest spherical power can readily be detected on the axis of a plano cylinder. This is also a difficult lens to polish, as will be explained. It should be remembered that a plano lens is the most difficult to grind.

In grinding the wafers, it is only necessary to grind them small enough to be thin. The spherical lens is blocked, putting the surface that is correct down on the block, of course, and grind it down to about 30 mm. diameter. For horseshoe-shaped wafers they can be ground smaller, but if less than 25 mm. they will be too thin to handle.

Torics are ground the same as a regular compound, obtaining the rough toric cylinders from the jobbers. If the combination to be ground is + 1 = 50, a + 50 toric rough cylinder is selected, and this will have the cylinder on the outside. This is blocked with the surface down, and — 5 ground on the inside. It should be remembered that these should be blocked on concave blocks so that the surface will fit.

If any amount of roughing is to be done, do it on the extra tool kept for this purpose. This should be about 6 D. curve, and it is not necessary to keep it accurate. The idea is simply to have a tool with strong power to save the regular tools. Rough emery grinds the tool very quickly, and, consequently, throws it out of true. Quite a little time must then be spent to keep them in shape.

CHAPTER IX

Surface Grinding—Continued

TORIC AND SPECIAL LENSES

Toric lenses are ground in the same way as compounds; that is, the spherical side. The rough toric cylinders are obtained from the jobbers in the moulded form, and this reduces the labor considerably. When it was necessary to grind them from the flat form a great deal of roughing had to be done. The blocking has already been described, and, if this is properly done, there is very little danger of breaking. In grinding torics it is very difficult to get the spherical power accurate for the reason that in grinding strong curves a little variation can hardly be detected, but when the curve is ground on the opposite side the total power of the lens is so weak as compared to the surfaces ground, that it is a very easy matter to grind the power .12 D. weaker or stronger. For this reason torics should be ordered of reliable houses that give this matter proper attention. One should also be particular to notice whether B. & L. or A. O. Co. rough toric cylinders are used. If an A. O. Co. plano-cylinder is to be ground on a B. & L. tool it should be 6.18 to be exact. (6.12 will be near enough.) If a B. & L. plano-cylinder is to be ground on an A. O. Co. tool, it should be 5.82 (5.87 will answer).

If a + 1 = + 50 is to be ground, a + 50 toric cylinder with + 6 D. base curve is selected, and — 5 D. spherical ground on the inside. For + 2 = + 50, a — 4 D. spherical would be ground on the inside, and so on. As the spherical power increases, the inside curve decreases, so that if the full toric effect is desired it will be necessary to transpose the combination and grind it on a concave cylinder.

If a — 1 = — 50 is to be ground, a — 50 cylinder with — 6 D. curve is selected, and + 5 sph. ground on the outside. Remember that the base is always 6 D., and, to produce the required spherical, simply deduct the power desired, and this will be the curve to grind. Also do not forget that when grinding a + and + combination on a — cylinder that the combination must

be transposed. This is the cause of many mistakes. For example: + 1 = + 50 if ground on a + cylinder will have a — 5 inside curve, or 1 D. weaker than the base. When transposed it will be + 1.50 = — 50, and the outside curve will be + 7.50, or 1.50 D. stronger than the base. When 9 D. base curve is required plus cylinders can most always be used, and it is rarely

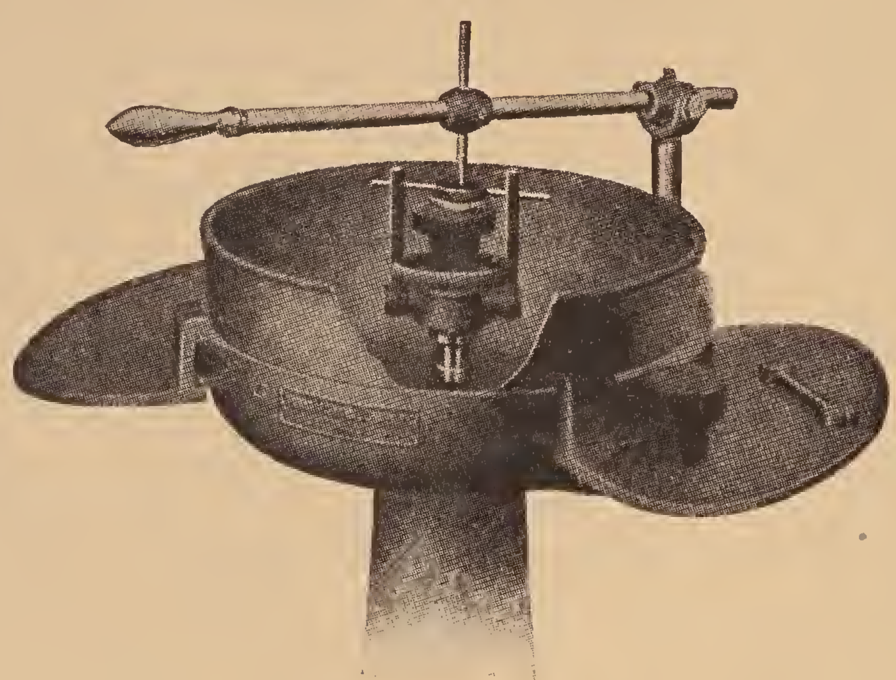

Fig. 59

necessary to use minus. The curves are not only extreme, but the rough concave cylinders are expensive.

Toric cylinders are usually ground on automatic machines, although a hand attachment for the regular surface machines can be obtained (Fig. 59). This work at present is not attempted by opticians, except in large shops or in localities where it requires some time to obtain the rough stock. As the sale of fused bifocals increase, however, more opticians will be obliged to grind cylinder or toric surfaces if they give prompt service to their customers. The hand attachment requires special blocks, having an iron rod running through the center (Fig. 60), to keep the axis of the lens in line with the tool. If the cylinder is fairly strong it will save time and also the wear on the tools to rough a spherical power on the glass first. It is then placed on the cylinder tool and the cylinder power put on with 3-F carborundum. This material cuts faster than emery and leaves a smooth surface. The machine can be run at almost any speed, but for the beginners it is better to use about 600 revolutions

per minute. It is operated by the hand lever, the same as when grinding a spherical, but it is necessary to stop the machine to feed it. Care must also be used to keep the lens on the tool, as a slip is apt to not only spoil the lens, but the arms of the machine can also be broken very easily. After the carborundum, No. 4-F emery can be used and then the washed emery. The operations are the same as when grinding sphericals, except that it requires a great deal more time. For those that can afford it, the automatic machines are to be preferred, but they usually require much more time. There is a new machine just placed on the market, however, that will grind a pair of lenses quicker than a pair of sphericals can be ground by hand (Fig. 61). This will be of great benefit to the trade generally, as time is the most important part of the business to-day, except, of course, accuracy.

Another machine that is used quite extensively is the "Hercules" (Fig. 62). This machine does not require a separate spindle, but fits the spindle of any hand surface grinder. It does not revolve, but the spindle simply drives the lens-moving mechanism.

Prescription houses are frequently asked if certain combinations, especially prisms, can be made in torics. All combinations of lenses can be ground in toric form, but sometimes no

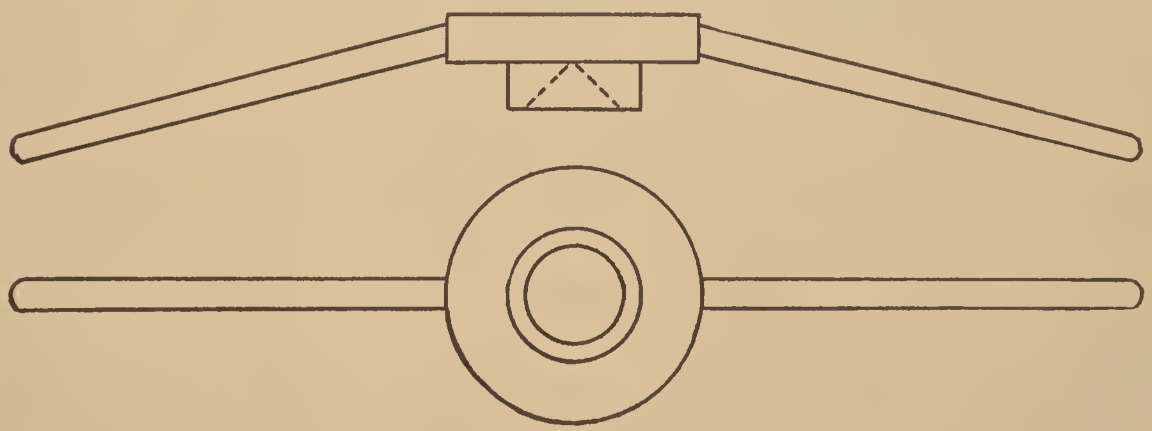

Fig. 60

better results are obtained. For example, — 12 = — 1 would be an extreme curve if ground in toric form, as the inside curve would be — 19 D. It would be much better to make it in double concave form with — 6 spherical on one side and — 6 = — 7 on the other. If this form was not desired, it would be better to make it in the regular compound form.

It is also a common idea that strong concave combinations are thinner when ground in toric form. This is entirely wrong, and the only way to grind these is to make them lenticular. A lenticular lens is one having the power in the center only, usually in a circle, having a diameter of 22 mm. This is the stock form, but they can be ground with the circle as large as the width of the lens. The larger the circle, the thicker the lens, however. Outside the circle is usually plano, but when a large circle is desired, the outside can be ground convex. This reduces the thickness on the edge, so that it may be as thin as desired. This style of lens can also be made with an oval center, but these are quite difficult, and it is best to order them from the prescription houses. Lenticular lenses are very desirable and should be used more, and the reason that they are not is that opticians are not generally familiar with the different forms, or else they believe that the field is limited.

In grinding lenses this style the first operation is to grind the power in the center, the same as any regular lens. This may be ground way out to the edge if desired. It is perhaps, just as well to do this when the power is not strong, but in the higher power lenses it requires too thick stock and it also makes unnecessary work. After the focus is ground and polished the center should be filled with sealing wax and then the plano tool and grind off until the circle is the correct size. This should not be over 25 mm., unless the focus is not over 10 D. If higher than this, it makes a better lens to grind it convex. The power of the outside curve will depend on the size of the circle desired, also the focus of the lens. The curve required will vary from 6 D. upward, and, until you are experienced, it is a good plan to select a low power and try it. If the curve is not steep enough, try a stronger one. The outside surface should be polished before the wax is removed. In referring to the outside curve of this style lens we mean the curve outside the circle and not on the opposite side of the lens.

Fused bifocals are very interesting to grind, and as the blanks can now be obtained, the most difficult part has already been done. In ordering the blanks, it is necessary to give the full prescription, so that the proper blank can be selected. It must be remembered that the curve ground on the disk side will change the addition, so this must be taken into account.

It is also impossible to grind a cylinder on the disk side for this reason so in compounds an allowance for the spherical must be made. In making the blanks, a depression is ground in the base lens of a certain power, the curve having been calculated for the index of the flint to be used for the disk. For example: If a 10 D. will produce 2.50 D. addition, each diopter will add + .25. If the blank was intended for a plano surface and a + 1 was ground on it, it would increase the reading addition .25 D. By this it will be seen that if the prescription called for distance

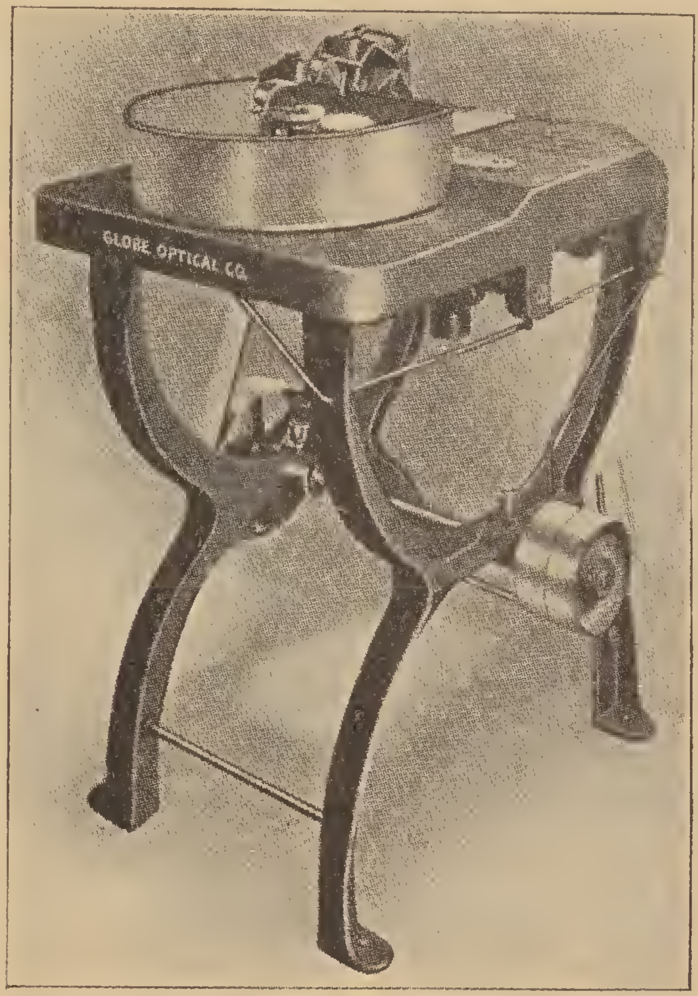

Fig. 61

+ 1 = — 50 axis 90, reading + 3.50, and the blank used was intended for a plano surface, the lens when finished would have for reading + 3.75. The blanks are blocked the same as any lens, but care must be used in heating.

If the lens was not properly annealed it is very liable to break. The disk side is always ground first, as this must be brought down to the proper size. This is the most particular part of the work, as it can be easily ground too small. After the flint is ground off so that the surface is even it should be fined

down very slowly, as this glass is very soft and grinds away quickly. In grinding a pair, always grind both disk surfaces first, so that the disks can be made the same size. Frequently, one lens will be ground so that the disk is the correct size, and then the other will have a scratch or imperfection in it, so that it must be ground smaller. It will then be necessary to reduce the other to match. In this way, grinding first one and then the other, it is possible to get them to match. After the disk side is ground, the other side can be brought down so as to make the finished lenses the proper thickness. If a cylinder is to be ground on the other side, it will be necessary to mark the axis, as the disk must be in the proper position. If the lens is twisted to correct the axis after the lens is finished the disk will be out of center. If the axis is found to be off, it must be blocked again and reground.

When the lens is laid out for axis, always try the tool with lens measure and see if the axis is in the proper position. There is nothing difficult in grinding these lenses, but grind slowly, taking off a little at a time. In polishing, remember that the flint is soft and is easily made wavy.

When the lens is ground and the finish is as near perfect as possible, the lens is ready to polish. The tool should be cleaned and the lens rinsed in water. Then take a piece of felt, either round or square, as you prefer, and stick it on the tool. The material used is called "Tacky," and this is made from powdered rosin, or pitch, the same as used for blocking, and cut with alcohol, so that it is in the form of a paste. This is first applied to the surface of the tool with a brush, while it is running. The machine is then stopped and the felt pressed down firmly. Then start the machine and with a knife trim off the corners near the edge of the tool. This is where the art of polishing a lens, weak or strong, comes in. A convex lens may be polished strong by cutting the cloth large, and weak, by cutting the cloth small. A concave will be just the opposite, the lens will be strong when polished on a small cloth and weak on a large cloth.

The rouge should be placed in a cup and mixed with water, so that it will be in the form of a paste; then place aside of this another cup containing plain water. Now apply the rouge with a brush, so that the felt will be well saturated; then place the

lens on the spindle and start the machine. As the lens revolves, move the lever forward and back, the same as when grinding to break up the rings that would form if it were held in one position. Apply the rouge occasionally, but do not let it get too dry, so that it will cake on the cloth. If it has this appearance, apply a little water. A lens will polish faster with a fairly dry cloth, but it cannot be too dry, of course. After polishing for two or three minutes, take the lens off the spindle and examine the surface. For this purpose a gas flame will give better results, as it has more or less flare. Daylight will answer, but electric light

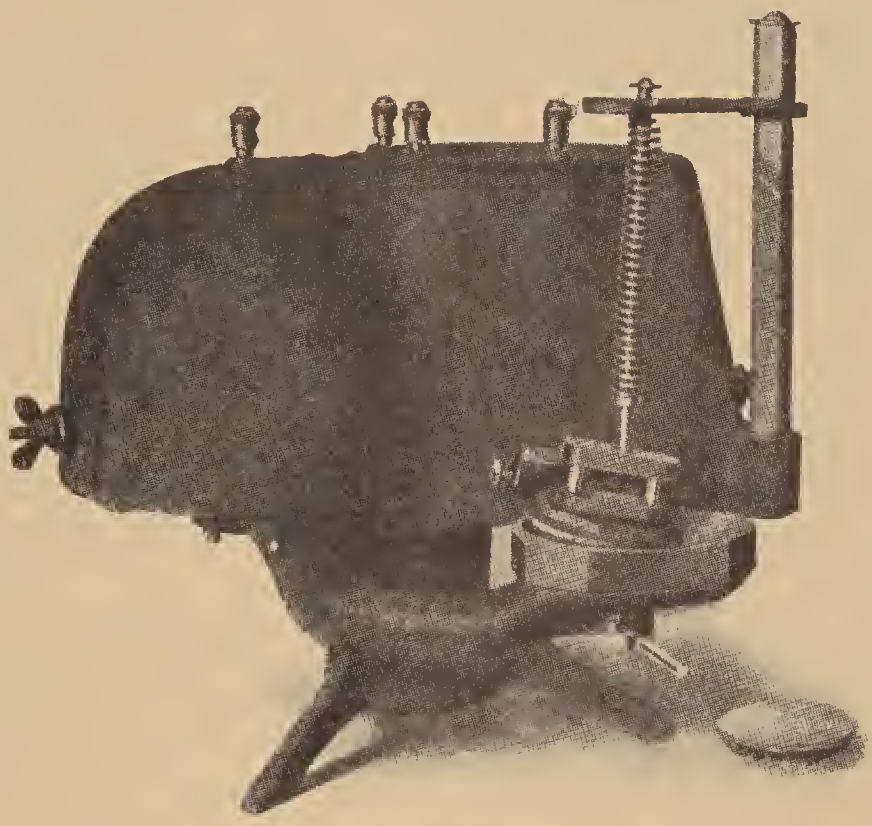

Fig. 62

is not very good. The lens should be held in the hand, a little below the level of the eyes, in such a position that a good reflection of the flame will be found on the surface of the glass. By tilting it gradually so that the reflection moves across the surface, it will show up any imperfections, such as pits or scratches. When the glass has but a slight polish, the emery marks will be seen and these must be polished out.

After the first inspection, and the lens has been found free from large pits and scratches, replace it on the spindle and polish a few minutes longer and then inspect again. As soon as the emery marks have all disappeared the lens is polished. If for any reason a scratch appears, or a pit of any size is found, it is

best to finish it again with the washed emery, as this will not only save time, but a better lens will be produced. When a lens is polished too long, the power is apt to be off, so that the quicker it is polished the better. Remember, however, that it will take just about so much time to polish a lens, and that just putting a glaze on the surface is not a polish. Beginners are very liable to make this mistake, and it requires quite a little practice to judge the surface of a lens. The cloth can be used several times, and, in fact, until it wears down too thin. When polishing a plano surface, such as a cylinder prism, never use a new cloth, but always use one that has been used before. The nap on a new one will sometimes produce aberration.

To remove a lens from the block, place it under a running faucet for several minutes. If the pitch is then started a little with a knife, the glass will come off easily. The lens should then be placed in a basin of turpentine to eat off the pitch.

CHAPTER X

Soldering and Repairing—The Equipment

Soldering is a part of mechanical optics not attempted by many opticians. While it is not very profitable, perhaps, it must be done occasionally to satisfy a customer. It also frequently happens that it must be done in a hurry, as there is no time to send it away. There are many jobs that opticians are called upon to do in the way of small repairs and one thing that is necessary is to have proper equipment and the work then will not be difficult.

Gas is very essential to do good soldering, although it can be done with an alcohol lamp. Alcohol is very unsatisfactory, for the reason that it is impossible to obtain a large flame and, therefore, there is not heat enough.

There are several ways of arranging the gas, and possibly the simplest is to use an ordinary swinging gas bracket and remove the lava tip. The size of the flame can then be regulated and an ordinary blowpipe used (Fig. 63). There are two styles,

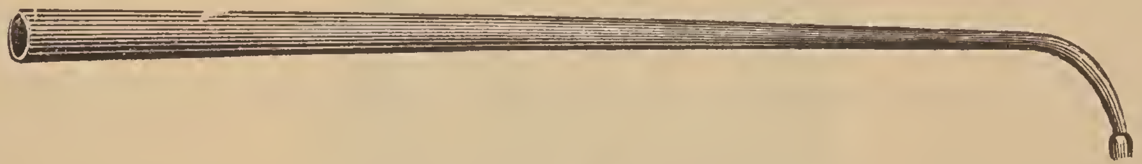

Fig. 63—Blowpipe

one having a bulb, forming a sort of reservoir for air. Either will do, however. There are also a number of different styles of blowpipes that are used principally by dentists. Some styles are quite elaborate, having valves to regulate the air and also the gas. These are not necessary, however, as one can be made very easily that would be simpler and better. It consists of a brass pipe with a rubber tube, which is attached to the gas at any convenient place, and another tube is inserted at an angle of 45°. On this is another rubber tube, which is held in the mouth. An ordinary pipe mouthpiece can be used if desired to hold in the mouth. The drawing (Fig. 64) gives a good idea of the construction. A blowpipe of this kind can be held in the hand in any position and is, therefore, much more convenient.

There are many styles of soldering blocks, such as charcoal, asbestos and numberless patented ones. Webster's soldering block (Fig. 65) is the best and this, with a charcoal block, is all that is necessary. A borax slate (Fig. 66) will be needed and this

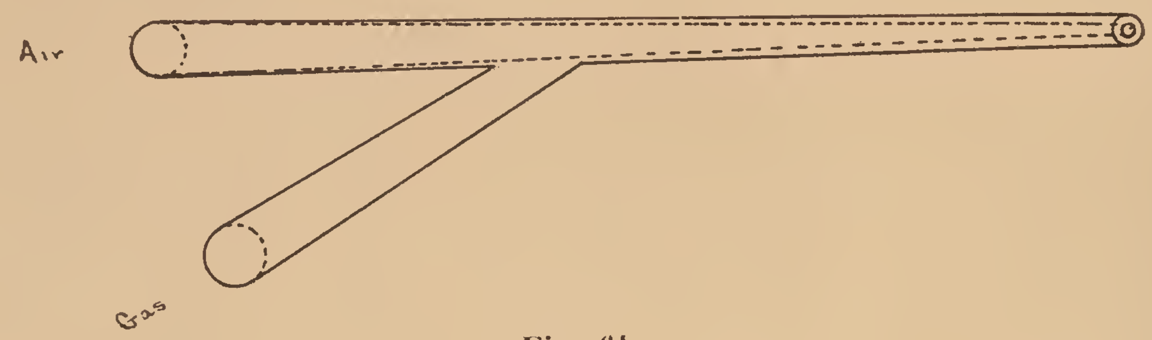

Fig. 64

is a slate having a concavity in which borax and water is mixed. The borax is prepared in tinfoil and can be used in the wrapper, so that it does not soil the fingers. In using put a few drops of water on the slate and rub the borax around a few times until the water looks milky. It is then applied with a small camel's hair brush. Two jars will be required, one containing a solution of

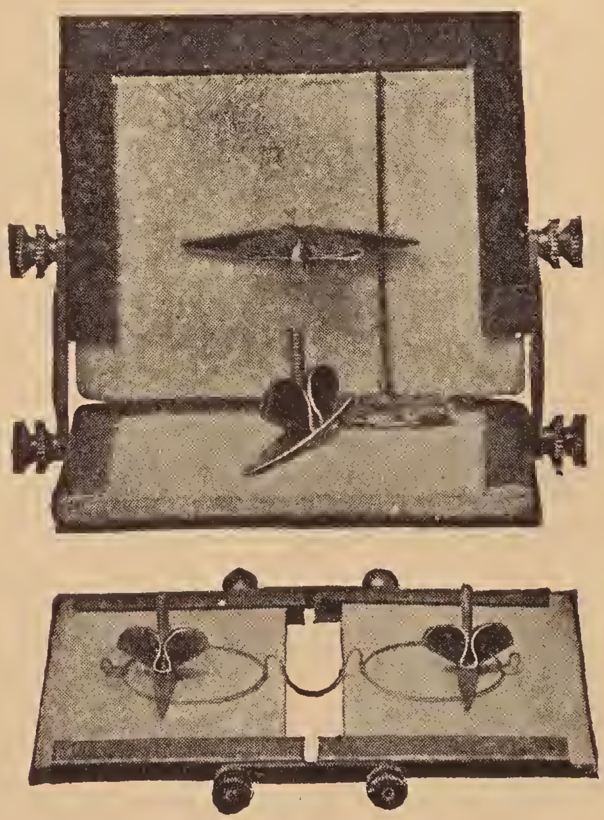

Fig. 65—Webster's soldering block

one part sulphuric acid and two parts water. After the metal is heated in soldering it is blackened and if dipped in the acid, while hot, this is removed. It is then rinsed in plain water.

These few articles are all that is required for the soldering, with the exception of solder. This can be obtained in several

forms. The most common is silver, or hard solder. It is sold in flat strips, which can be cut with scissors into small bits, or it can be had all cut as small as desired.

Although silver solder will answer all purposes a great many use gold solder. This can be obtained in all karats and is usually

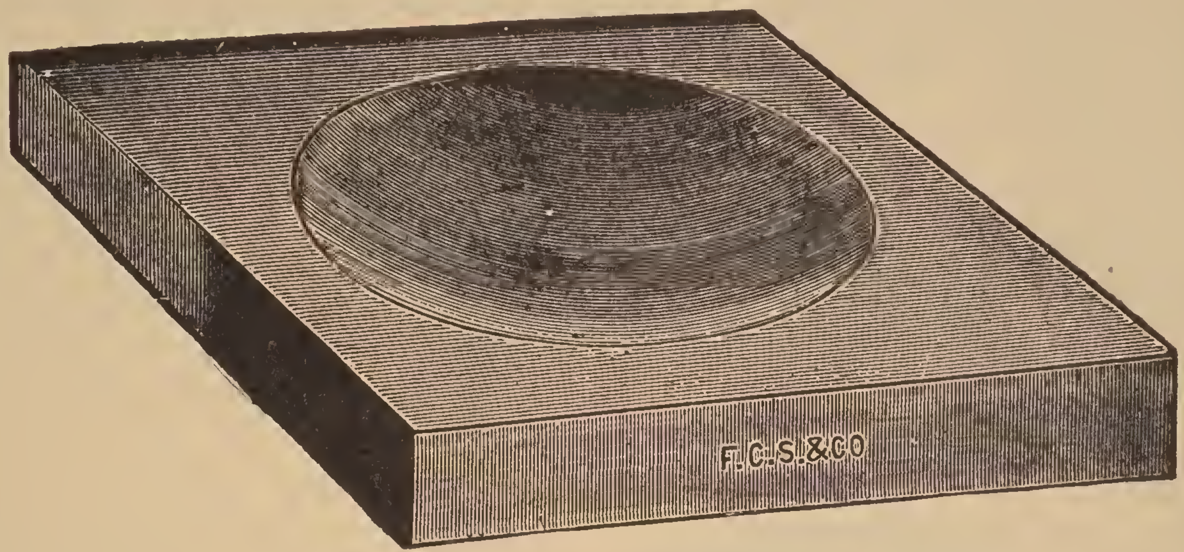

Fig. 66—Borax slate

claimed to be "easy flowing." A spool of soft solder is handy to have around, but it should never be used in repairing spectacles.

For tools one will need all the ordinary pliers, such as flat, round and snipe-nose; also the hollow-chop and cutting pliers. It

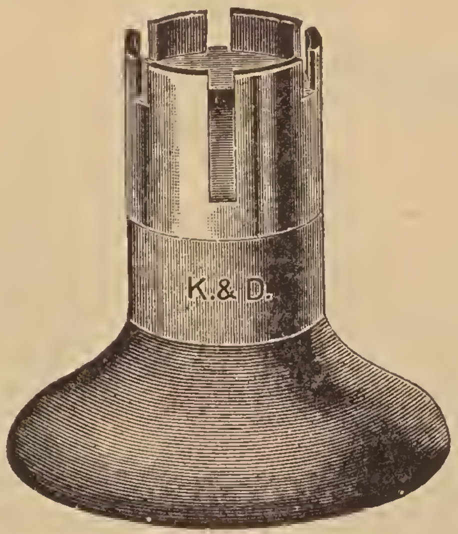

Fig. 67—Spectacle and eyeglass stake

will also be necessary to have two or three pairs of tweezers; one should be a good pair for picking up screws, etc., but the others can be cheap ones. The latter should have a slide so that they can be used to hold articles while soldering. As it is necessary to blow the flame on the points, it draws the temper so that they are of no use for any other purpose. A pin vise should be added for holding wire, etc. This is especially handy when filing down wire for rivets and things of that kind. A small vise should be

screwed to the bench and a small anvil that stands on the bench will be found very convenient. A good assortment of screw-drivers should be selected; a good, substantial one with a wood handle and two or three others with different size blades and with swivel tops. A spectacle and eyeglass stake (Fig. 67) is very good to hold the endpieces of frames when extracting old screws. This is made with a wood base to stand on the bench, or it can be had for a vise. There are also a number of screw extractors on the market, but one of the spring punches fitted with a screw extractor is all right (Fig. 68). A couple of small hammers will be needed, and have one with a brass head. This will not mar or dent some of the softer metals as easily as steel.

A good assortment of files is required—rat tail in one or

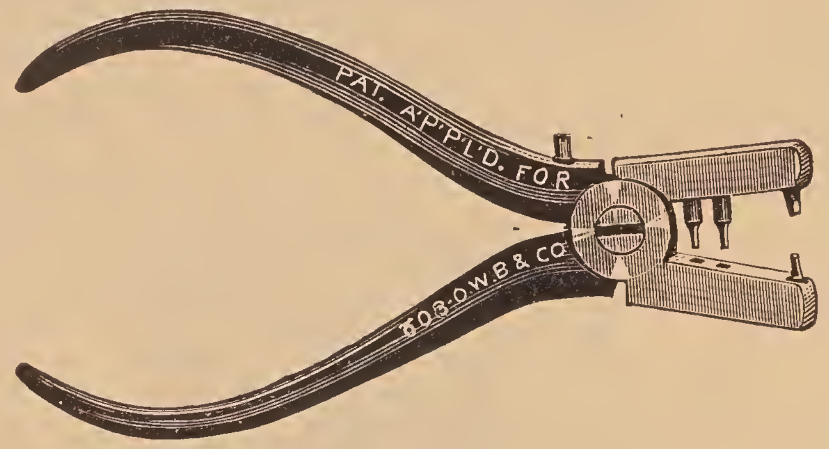

Fig. 68

two sizes; a flat one four or five inches long and five-eighths of an inch wide; a three and a half or four-inch half round; a square file, not too large; also a screw head file. For the cut, do not have them too coarse. If you have a good assortment have them range from Nos. 2 to 6; No. 4, however, is about the medium cut. It is well to have all these fitted with handles, as better work can be done. These can be obtained in assorted sizes for about five cents each. A burnisher is a good tool to have, but not too large a one.

Buff sticks will be needed; also crocus and emery sticks. For buffing the ordinary felt stick is all right, but for smoothing and finishing for the buffing a leather stick is required. These can be bought with a kind of rawhide, quite thick; the stick is also very long. This should be cut down so that it is fairly thin; *i. e.,* both the stick and the leather. This will give it a

little spring and also allow it to be used in small places, such as under the shank of the bridge. The material used with this is Tripoli; or pulverized pumice, mixed with oil, will answer. There is, however, on the market now a prepared form of Tripoli called "Cut Quick." This is in more convenient form.

These sticks are used mostly, however, if one has no power. With power, wheels can be obtained to do most of this work

Fig. 69

much easier. There are certain jobs, however, where these sticks will be found very convenient. A buff head should be large enough to be substantial, so that it will run true; also that the bearings will not wear quickly. If it is too light, the shaft will spring easily also. Another point is that, if the bearings are not good, it cannot be run at a very high speed without rattling,

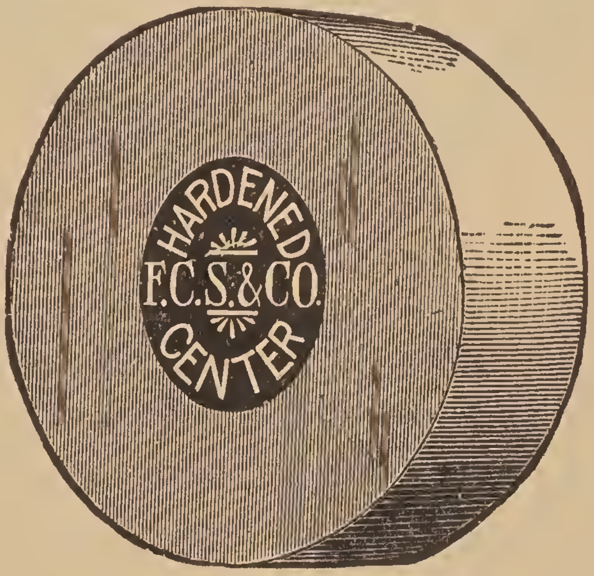

Fig. 70

and this is, of course, very objectionable. It should be run at a speed of from two to three thousand and, for all kinds of work, with the exception of finishing the ends of screws in frameless work, it should run towards you. This is a point that some workmen do not understand. They have outfits with one buff

head and this is, of course, fitted to run toward you for buffing, etc. Now a screw finisher must run left-handed, or from you, because if it did not it would turn the screw out instead of rounding it. On the other hand, if we run the spindle the other way, or from you, the screw finisher will be running the right way, but the taper will be threaded the wrong way, so that the wheels will turn off instead of tightening.

It is also the same with the chuck and nut. These will loosen so that nothing will stay in them. The only way to overcome this is to have a separate head for the screw finisher. If one does not have power these heads can be run very successfully

Fig. 71

by foot power. The foot wheel is better than the treadle, as more power and speed can be obtained. There are outfits all complete, however, with a zinc-lined box and treadle all belted if desired. By purchasing an ordinary buff head and screwing to a bench, then placing the foot wheel beneath, is very satisfactory.

For wheels, get a number of stiff brushes (Fig. 69), having one each of one, two, three and four rows. These are used for cutting, as well as cleaning. Then a felt buff wheel from three to four inches diameter (Fig. 70), a cotton wheel about three inches diameter and also a rag wheel six to eight inches diameter (Fig. 71). Rag wheels come thin, so three to four will be re-

quired. These should be placed together, with cardboard washers on either side, about two inches diameter, in place on the buff next the chuck and screw the nut up tightly. With this kind of a wheel better results can be obtained in fine polishing, such as putting on the final finish on a frame. Care must be used in polishing on this wheel, however, as temples and such things catch very easily if not held right. (This work will be explained in the next article.)

For other small articles we would suggest a hand or jeweler's brush; a roll of binding wire—*i. e.*, soft iron wire, very small, for holding parts together while soldering; a stick of polishing rouge —get the kind wrapped up in tin foils so that you need not get any more on the fingers than possible; a solder burr for burring out the eye wire after soldering; a temple burr for end pieces; a bottle of soldering fluid.

The completeness of the outfit depends, however, on what extent you intend to go into repairing. Years ago it was necessary to be fitted to do anything, from a simple solder to making a frame complete, but to-day it is entirely different, the goods cost less, are made better and a greater assortment of bridges can be kept in stock. Consequently, when an old frame is brought in for repairs it is often cheaper to give them a new one, or a new part, rather than attempt to repair it.

CHAPTER XI

Soldering and Repairing—Continued

Now as to the first step in preparing the break to be soldered. We will take, for instance, a break in the eye wire. First take a fine file, a half-round is the best, as it is pointed and fairly thin. It should be very fine; No. 6 is the best. With this file lightly over both sides, or, in other words, the parts to be exposed to the flame. Then place it on the soldering block and secure it with the clamps, so the ends just come together. Now mix the borax in the slate, first putting a few drops of water in the bottom, and then rub the borax around a few times, until you have obtained a milky fluid. Then, with a camel's hair brush place a little on the parts to be soldered and apply a small piece of solder on one side of the break and you are ready to apply the heat. Turn on the gas so the flame will be about two inches high.

If you are using the ordinary gas bracket, the tip having been removed, swing it directly in front of you and hold the blowpipe in the right hand. The soldering block hold in the left, at the side of the flame. Now place the blowpipe side of the flame close to the outlet and blow a small, steady blue flame at the break (Fig. 72). This flame should be like a needle point, holding the work so the point that touches the frame will be about ⅛ inch in thickness. Heat the part on which the solder is placed, and as soon as the solder begins to flow throw the heat on the opposite side of the break, thus drawing the solder with the heat.

If the work is held in the hands, the borax is placed on both sides and the solder on one side, as before. Apply the heat to the side on which the solder is placed, separating the parts until the solder is ready to flow. As soon as the solder starts to flow, dip both end of the break in the borax and apply the heat on the opposite side, as stated above.

The cause of melting is blowing too much heat, either with too large a flame or blowing too long. Remember that it requires but a very small point of flame and little heat, but

properly placed. If a blowpipe is used as described in the preceding article, it will be found much more convenient, as it can be held in any position. The soldering block can be held in the left hand, or laid on the bench, and the blowpipe in the right and the flame directed as desired. As soon as the solder flows and the eye wire seems to be connected, blow the flame all over the eye wire adjacent to the break for a second, to warm it, and then plunge it into the acid, and rinse in plain water. This will remove all the black and leave the frame in good condition.

If for any reason the parts did not unite, it will be necessary to start all over from the beginning. Do not attempt to add more

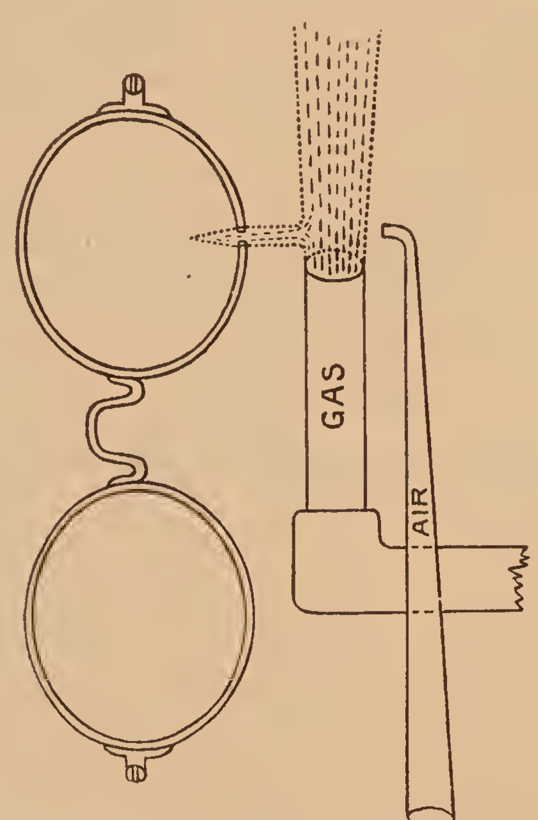

Fig. 72

solder and keep blowing at it, for this may cause the frame to melt. File the parts again, put on more borax and start again.

After the eye wire is soldered satisfactorily it will be necessary to file the break a little to smooth it, using, of course, the fine, or No. 6, cut. Then take the leather stick, referred to in the preceding article, and with tripoli, pumice and oil or Cut Quick, which is the prepared cutting material, go over the parts until all traces of file marks are removed. If power is used, the brush is the proper wheel and the cutting material is rubbed on by holding the stick against the wheel. Then with a solder burr, especially constructed for eye wire, burr out the inside of the

eye wire. This little tool is used in the buff head and run at a fairly high speed, say about 2000 revolutions per minute.

You are now ready to polish. For this work use the cotton buff and this, of course, runs toward you. Rub plenty of the stick rouge into it while it is running. Now hold the frame tightly in both hands, with the eyes perpendicular, and the eye that has been soldered downward. In this manner there is no way for the frame to catch, provided you keep your mind on it. You will soon learn to protect the parts that are liable to catch with the hands, such as the end pieces and bridge. In all repairing it is best to remove the temples, as they are very liable to get in the way of the flame or catch in the wheel when buffing. After the frame is polished in good shape it should be washed with hot water and soap to remove all the dirt and rouge that collects in the joints. When replacing the lens it will be necessary to reduce it a little, as the eye is always made a little smaller when soldered.

Most all solder jobs can be done without a soldering block if one is experienced, but quite a little practice is required. In this way the parts are held together with soft iron wire, called binding wire.

Bridges can be obtained all ready to solder to the frame; that is, they are bent and grooved for the eye wire. The most common method to-day, however, is to use what is called unbent bridges. These consist of the bridge stock in assorted lengths, tapered about one the right size and thickness for the shank. In using this stock the principal feature lies in judging the length required. The medium sizes require 2⅛ to 2¼ inches. First bend the crest or arch; this can be done over the handle of a tool or any round piece of wood. It is better to do it in this way than to attempt it with the hollow chop or periscopic pliers, as these dent the stock and must be taken out afterward. In gold filled this is impossible, as the gold will be finished too thin. After the arch is formed, bend up the shanks. These may possibly be too long and should be cut off, allowing stock enough, of course, for the feet. A frameless bridge can be soldered on straight, and if preferred the frame can be made this way also. This style, when made at the factory, however, has a depression pressed in the eye wire to make a blind joint. In repair work this is not attempted.

The bending of the feet can best be done in a vise, as the stock must be turned edgewise, this being quite difficult. After the feet are bent they should be grooved with a float file; that is, one with rounded edges, just the right size for the eye wire. You are now ready to solder it to the frame. First prepare the eye wire by filing it lightly, the same as for any solder. It can then be placed on the soldering block, clamped in and the solder placed on the top of the foot of the bridge (Fig. 73). This operation can be done better in the hand, however. The eye wire can be held by the joint in the left hand, and the bridge in a pair of tweezers in the right hand. By having a slide on the tweezers, as before described, it is much easier. If the blowpipe is arranged so that it can stand on the bench, both hands will be free to work with.

Another method is to use binding wire to hold the parts in position. In soldering the procedure is the same as before, placing the borax and solder on the parts and heating them and as soon as the solder begins to flow, throw the heat in the direction you wish the solder to flow. Just enough solder must be used so that it will flow freely in the groove in the bridge, but it is unnecessary to have so much that it will flow outside all over the joint. Care must also be used to see that the bridge is in the center of the eye wire. When one eye is soldered, the other can be put on the same way. The frame can then be lined up and the bridge bent to dimensions.

At this point it is well to see that the crest is the desired angle. If not, it can be formed with a pair of crest-angling pliers. If one does not have this tool the angle must be made first, while the stock is straight. For all saddle bridges, except the lowest ones, such as no height, the natural bend of the stock produces about 45°. "C" bridges, however, must be bent first. This operation is done by tilting the stock edgewise a little. This can be done by holding both ends of the stock securely with pliers and bending it over the edge of the bench pin. After the dimensions are made right any superfluous solder can be filed off with a fine file and finished with the buff stick and Cut Quick.

With power this can be done much better and quicker. For this work use the brush wheel, putting on plenty of the cutting material. This wheel reaches in under the shank and smoothes

up the foot very nicely. After smoothing up in good shape it can be polished in the regular way, being very careful, however, to hold the frame tightly, so that the shank will not catch in wheel.

One of the most common breaks is in the shank, at the turn. Formerly this was considered an unsatisfactory job, as, in order to make it strong, quite a little solder must be left in the turn. This was objectionable and yet, if finished in good shape, it made a very weak joint, as considerable strain comes at this point. Now this is a very common job, however, but the practice

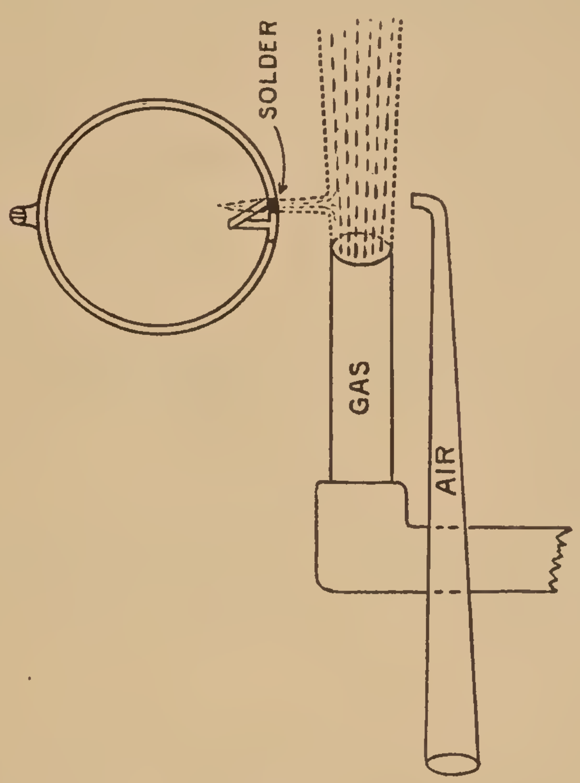

Fig. 73

generally is to leave plenty of solder; in fact, sometimes it is pretty well filled up. For this operation it is best to use binding wire, so as to bring the parts together in the right position. The parts must be prepared in the same manner as before prescribed and proceed in the same manner.

First prepare the eye wire by filing, then groove out the end piece, unless possibly it has just pulled out. Most breaks of this kind, however, are next to the end piece, so that a part of the eye wire is in the joint. When doing a job of this kind, be sure and remove the temple and screw and separate the joints. Do not, under any circumstances, attempt to solder an end piece on the eye wire, having them screwed together, for if you do you will find both end pieces soldered together and it will be like one mass, and it can never be taken apart. For this operation the

end piece can be bound to the eye wire with binding wire, and in this case wind it around the eye wire several times, quite a little distance back from the joint, and insert the other end through the screw hole and place it on the end of the eye wire. Do not attempt to bind it so that the eye wire comes near the solder. A simple way to do this work is to hold the frame in one hand and hold the joint on an old file, by inserting it in the screw hole. Do not use much solder in this operation, as it requires but the smallest piece to hold it securely. After the joint is soldered it will be necessary to burr out the eye wire and possibly reduce the lens a trifle.

This material is worked the same as gold, except that one must bear in mind that there is only a very thin coating of gold over the base metal. One stroke of the file will cut through it, consequently the work must be done in such a manner that no filing is necessary. The great feature in handling gold filled is to use the smallest amount of solder possible. In this way it flows only into the break or between the joints. At the factory this work is usually covered with a coating of boracic acid to prevent discoloring. This is a powder and by wetting the frame and placing it in the powder enough will stick to it. The polishing should be done as quickly as possible, as the metal will not stand too much.

Temples are very unsatisfactory to repair and only in cases of emergency should it be attempted. They are made in gold by drawing, and in gold filled by swedging. This process gives them the temper and spring. As soon as heat is applied to them they are annealed, and consequently are very soft. The best way to repair them is to use a ferrule. These are small pieces of tubing just the right size to slip over the broken ends, and as the base metal is solder it is only necessary to apply the heat and a good joint is obtained. This method leaves a bunch on the temple, but it is fairly strong.

Spring stock must have considerable temper and spring, consequently when heat is applied they are practically useless. When one is broken near the end, or screw hole, a new hole can be punched, and although it makes it somewhat shorter it is very satisfactory. This is the only way any kind of a spring can be repaired, but even this method hardly pays, as springs can be obtained at a very low price.

CHAPTER XII

Soldering and Repairing—Continued

Steel goods are fast disappearing, although the better class of trade still call for them occasionally, preferring to wear them instead of gold. It seldom, if ever, pays to repair them, unless possibly it is to solder on an end piece. Steel is handled in much the same manner as gold, except, of course, silver solder is always used. The parts to be soldered are first filed bright, so that all traces of rust or foreign substances are removed. The parts are then dipped in borax and the heat and solder applied as described in the preceding article. This metal must be heated to a greater temperature; in other words, red hot. It is then plunged in the acid and this removes the black and also restores the temper to a certain extent. In finishing, the surplus solder is filed away and smoothed. The frame then should be rubbed with fine emery cloth to leave the steel bright. If it is to be nickeled, no more finishing is required. If the finish is bronze or blue it must be refinished to match as near as possible the old finish.

At the factory the process is simplified by using hot sand. This produces an even color of any shade desired. For small shops it is hardly practical to attempt this method, as it is so seldom used. The easiest way is to use an alcohol lamp (gas will not answer, as the regular flame will blacken the work and a Bunsen burner has too much pressure). When using the ordinary jewelers' alcohol lamp the wick should be pressed down so that a very small flame is obtained. The frame is then held in the left hand and the lamp in the right. Take the work to a place where good daylight can be obtained, as artificial light will not answer and neither will poor daylight produce satisfactory results. Now apply the flame directly to the metal (Fig. 74) and then remove it quickly so that it is heated but a very little. Repeat the operation several times, being careful to heat the frame but a second at a time. The color will be observed after the flame is removed and it will be noticed that it changes considerably in a second or two. Bronze will appear first, then blue,

and, if you are not careful, you will burn it and bright spots will appear. As soon as each spot is the desired color move the flame along. This is one of the most difficult jobs in repairing, and, to produce an even color, it requires considerable practice. If the color gets too deep refinish the frame with emery cloth and try again.

We are frequently called upon to cut a frame to fit old lenses. In this work all four end pieces, if it is a spectacle, must be moved. This requires four solders, so it is easily seen why this work is expensive. If one end piece on each side is moved the frame will be out of shape. Take one end piece at a time, blow the heat on to remove it, then refinish it and set it back on the

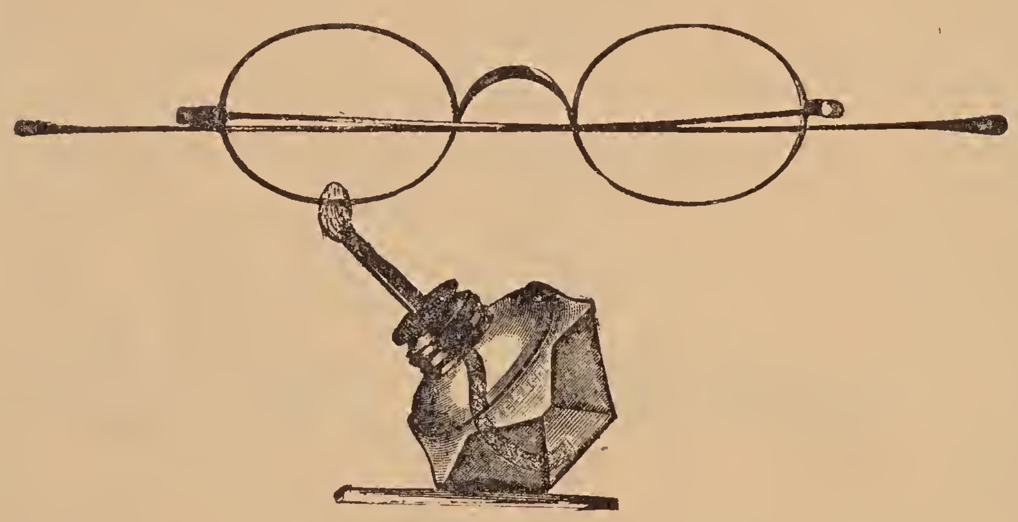

Fig. 74

eye wire slightly. The end that overlaps can then be filed off square. There are lens washers now on the market which are used extensively for this purpose and these are very satisfactory (Fig. 75). If they are not at hand, tinfoils, or, better still, tea lead, can be inserted in the eye wire to fill the open space. If the lens is only a very little loose, the end pieces can be filed slightly, but this method reduces the thickness so that it weakens the joints considerably. It is always preferable to fit new lenses if possible and this can frequently be done without the customer's knowledge.

Screws for all standard frames can be obtained cheaply so that it is well to have a good supply on hand. If one has taps for these threads they can be used to replace odd makes by simply tapping new threads (Fig. 76). The great difficulty is in removing the old screw, however. For most jobs the screw

extractor, referred to in Chapter X, will suffice. This can be used for end-piece screws if the head is not too far gone. If the head has been turned off completely it will probably be necessary to drill it out. Small twist drills, such as can be purchased in any hardware store, are used for this purpose. After the screw is drilled out the hole must be tapped and the new screw inserted. If the ends protrude they should be filed off carefully and the end piece polished. Stud screws, or screws that project, can frequently be removed successfully by filing a

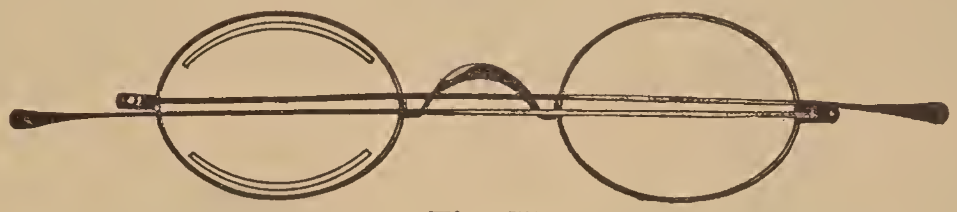

Fig. 75

slot in the head with a screw head file. By then placing the frame in a stake (Chapter X) or against a solid square surface (if a stud screw hold it with a pair of stud or round-nose pliers) and by using a wooden handle screwdriver it can be turned gradually.

Fingerpiece mountings are used so extensively at the present time that it is well to be prepared to fit these while the customer waits. The factories will possibly replace these without charge, but it seems absurd to require a customer to go without their glasses for from one to three days when these can be inserted

Fig. 76

in a few moments. These springs can be obtained from the jobbers in gold filled for seventy-five cents a dozen pair and in gold for a dollar and a half. They come in rights and lefts and with two, three and four coils. The best mountings have four coils, as this produces an easier pressure and less liable to break. They are placed on the screw with the top ends over the inside edge of the straps, the coil being wound from left to right on the right side and from right to left on the left side (Fig. 77). The lower end is turned under the guard. After both ends are bent

so they are secure they can be cut off fairly close, as will be indicated by an inspection of the guard.

It is frequently necessary to fit new zylonite to guards, although it hardly pays, except on gold. There are a great many styles where the zylonite is peculiar in shape, and at the factories these are punched out with dies. When one is called upon to furnish one of the irregular shape the best that can be done is to cut it with shears or a knife as near as possible. This material can be smoothed and shaped wth a file so that it is possible to do a very good job. Zylonite can be obtained in any form, such as plain sheets, plain strips or in pieces ready to be fitted. The corrugations are pressed in at the factories, so it can be obtained in

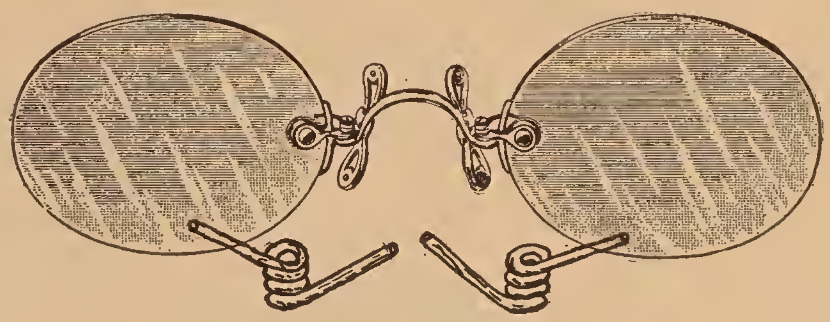

Fig. 77—Illustration showing position of right and left coil springs in their relation to the mounting

this form if preferred. It is well to have a small assortment, however, so that all sizes can be obtained. Small wire, or even common pins, are used to secure it to the guard, but rivets, made especially for this purpose, should be kept on hand. The guard is already punched and small holes should be made in the zylonite just large enough to force the pins through. These are driven through from the back and are then cut off quite close and with a light hammer riveted gently. If the holes are just the right size it requires but a few taps. If plain zylonite is used, it will be necessary to corrugate it with a screw head file, making the cuts as small and as regular as possible. Scraps of shell can also be used for this purpose.

Corks have to be fitted quite frequently, although many times, if they are only soiled, they can be washed with soap and water. This is the method employed when guards are slightly soiled from lying in stock. If they are quite bad and not worn down they can be sandpapered to look as good as new. For this pur-

pose No. 00 sandpaper is used; any grade coarser than that will rough them. Cork can be obtained in the rough, cut the right size, or it can be had all rounded and finished with groove, ready

Fig. 78

to fit into the guard. The difference in price is so slight that it is better to use the finished. The old cork should be removed and the edges of the guard lifted with a burnisher or a knife just enough so that the cork will slide into the guard easily. The edges can then be burnished down so that it will hold securely. The end can then be trimmed off and if the guard is then too thick it can be sandpapered down. Some styles, such as No. 0 Anchor (Fig. 78), have a round disk which must be riveted and for any of these styles the disks can be ordered, cut to shape. The regular styles of guards in nickel and gold filled are low-priced, so that it is often cheaper to fit new ones than the charge made to cover the cost.

Dowels, or rivets, as they are more generally called, have to be fitted to spectacle end pieces. In gold filled they loosen and fall out easily. In gold they wear so that the temples are loose and must be replaced. The only satisfactory way to tighten old gold temples is to fit new dowels, but for quick repairs spec washers can be obtained. Two, three, or as many as are necessary, are placed on the dowel to fill up the space in the joint and the end piece screwed together. Dowels can be obtained in the different sizes ready for use. They are tapered and left long so that they will fit any joint. When fitting these, it is only necessary to drive out the old one and insert the new. Place the joint on an anvil or vise so that the small end of the dowel can be driven into a hole and with a light hammer tap it lightly a few times and then try the temple. If it is not fairly tight, drive it in a little farther. If it is still loose drive it out again and with a small broach ream out the hole a little: The

dowel can then be inserted and driven in slightly. Do not have the temple fit too snug but see that it works fairly stiff. If it works too freely it may be too loose after the ends of the dowel are finished off and it will then be necessary to do the work all over again. When the dowel is in place the ends should be cut off closely and finished first with a fine file and then polished on the buff wheel. If the finished dowels are not available, steel wire can be used, a size a little larger than the hole should be selected and a piece about a half an inch long cut off. This should be placed in a pin vise and filed to a slight taper. It can be done on the bench pin, revolving it with the left hand

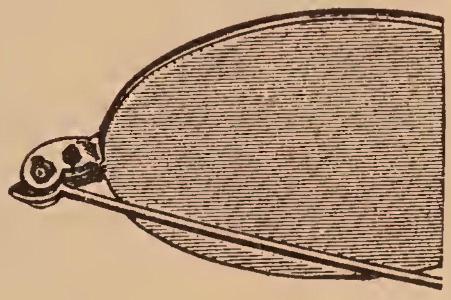

Fig. 79

and filing with the right. In gold filled the dowels are usually rounded on the ends and for this metal the finished dowels for the particular grade that you are using should be kept in stock. A regular dowel can be used, however, and the ends rounded with a screw finisher. As gold filled is a softer metal the temples are fitted more loosely and the joint brought together tightly. This may not seem practical, but it is the only way the dowels can be made to hold in the end pieces. If they are fitted the same as gold the temple will work them loose. In some grades of gold filled the flush dowel is used and the largest end is punched slightly with a very small punch (Fig. 79). This is supposed to spread the head slightly to hold it in place.

There are a number of small jobs that one is called upon to do that are interesting if time is of no account, such as drawing out gold temples, or balling them. To ball a gold temple it is only necessary to file the end slightly, to clean it and then dip it in the borax and apply the heat. This is very convenient when it is necessary to shorten temples. Gold filled cannot be done in this manner but requires a gold ball soldered on the end. This is a little more difficult and is not attempted unless necessary.

The fitting of lorgnette springs is now quite common and this is a job that requires quite a little ingenuity. The springs can be obtained quite reasonable and if one has the time and cared to experiment with them a little practice will enable them to do as good a job as can be done at the factory. When fitting the center springs to plated styles it is necessary to have them replated. Platers when doing this work often use acid, which destroys the spring, so they should be cautioned regarding this point. The older styles, such as heirlooms, are very difficult to repair and should not be attempted.

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